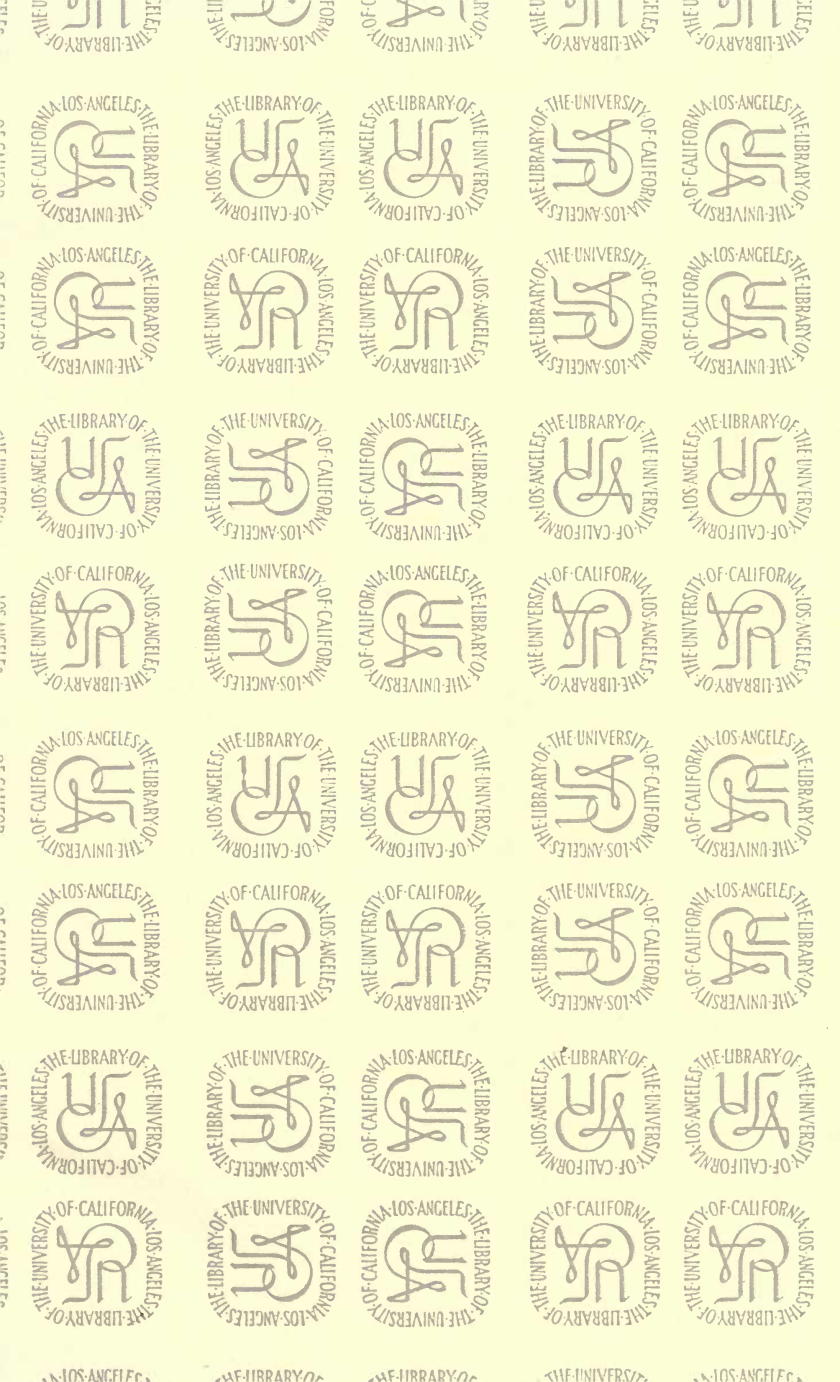
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THE MONTHLY BULLETIN

CALIFORNIA STATE DEPARTMENT OF AGRICULTURE

Volume IX AUGUST, 1920 No. 8

Special Pest Control Issue

SACRAMENTO, CALIFORNIA

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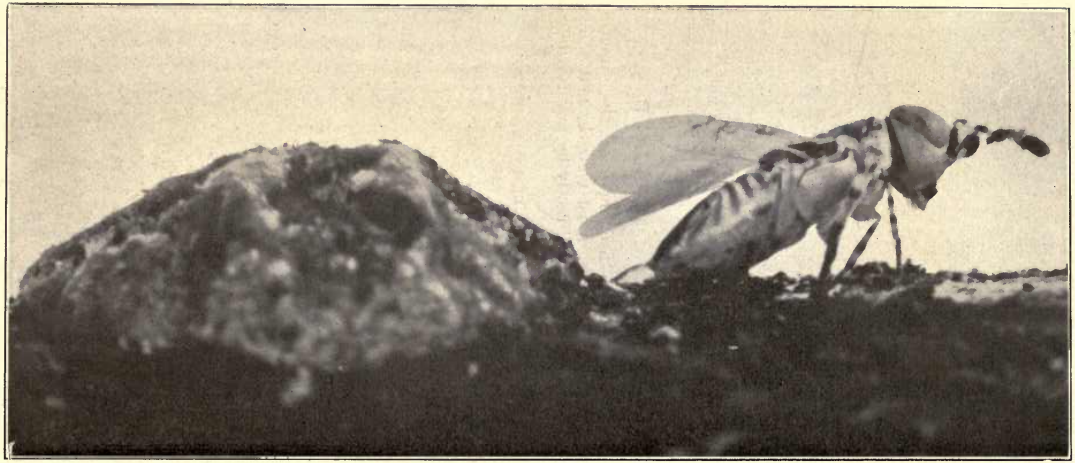

A Beneficial Parasite.

Aphycus lounsburyi, depositing its eggs in black scale. Such beneficial insects are useful in the control of destructive pests in citrus groves of California. (Los Angeles Times.)

THE MONTHLY BULLETIN

DEPARTMENT OF AGRICULTURE

STATE OF CALIFORNIA

DEVOTED TO AGRICULTURE IN ITS BROADEST SENSE, WITH SPECIAL REFERENCE TO PLANT DISEASES, INSECT PESTS, AND THEIR CONTROL.

Sent free to all citizens of the State of California. Offered in exchange for bulletins of the Federal Government and experiment stations, entomological and mycological journals, agricultural and horticultural papers, botanical, biological and other publications of a similar nature.

G. H. HECKE, Director----------Censor

BRONTE A. REYNOLDS, Assistant Secretary----------Editor

Entered as second-class matter October 6, 1919, at the post office at Sacramento, California, under the act of June 6, 1900.

Vol. IX AUGUST, 1920 No. 8

MAKING A PURE SEED LAW EFFECTIVE.

Regardless of the expected legislation bearing upon the important question of pure seeds, it is evident that we must view the matter from certain angles, which may be affected only indirectly by any regulations or code of procedure.

The most potent and far-reaching factors having direct bearing upon this important issue of clean, high-quality seeds are essentially educational and any good results to be had through the enactment of pertinent laws must of necessity be influenced in a great degree by the care that has been employed in preparing both the consumer and the producer to meet the conditions which will be brought into action by such needed legislation.

California at present has no pure seed law. Such meritorious legislation, however, has been in effect in other states for some time and notwithstanding the faults and flaws that invariably crop out when new codes and regulations are substituted for the old order, the cumulative benefits to be had under the operation of such laws are readily appreciated and improvement as affecting their efficiency is only a matter of time and progressive education work.

The great advantages to be enjoyed by a given state from the enactment of pure seed legislation must accrue as well from other sources than those merely having to do with seed inspection and seed-testing.

The farmer must of necessity be taught that poor seed is dear at any price.

Under such conditions the dealers, being confronted by more critical buyers who decline to use cheap and inferior seeds, will discontinue or discourage the sale of any but a better grade, produced under favorable conditions and guaranteed as to germination and freedom from excessive admixtures of noxious weed seed.

Any seed laws which may be placed on the statute books in a given state will have for their primary object the improvement of the quality

of agricultural seeds, but to realize the greatest benefits to all concerned we must revert to the source of much of the past difficulty and apply certain remedial measures on the farms where the seeds are produced.

The seed grower should understand that clean seeds reasonably free of weed seeds in the end are a matter of dollars and cents to him, and that the reputation of his business will receive the greatest stimulus through the exploitation of a guaranteed product, exceeding in fact the returns from any other known source of advertising.

As an index to the great injury that misrepresentation can work a given seed house, we will cite the following:

A lot of seed (sample X) was purchased for alsike and timothy mixture. Analysis showed it to contain 28 different kinds of weed seeds amounting to nearly 12 per cent by weight. This seed was shipped by a middle-western seed house that was guilty of many other infractions of the laws of common honesty.

In the absence of a federal law it may not be possible for the state to hold up interstate shipments such as these, but we may rest assured that but few hard-headed, thinking farmers will go back to that seed firm when they want more alsike and timothy.

Thus we may see that the efficacy of any so-called seed laws that may be established depends in a large measure upon the consistent observance of many related factors which may not for purely mechanical reasons be adequately covered by the law as written.

To this end, then, we should have:

(1) A wider, common knowledge of weeds and approved methods of control and eradication to be taught in the schools and agitated by the press through newspapers and farm journals.

(2) The earnest cooperation of farmers, seed dealers and seed producers in California, making for the establishment of standardized grades of approved strains and varieties grown and stored in California under favorable conditions.

(3) A radical departure from the over-colored extravagant style of advertising so-called phenomenal varieties to be replaced by a plain, honest, descriptive statement as to variety, merits, etc. (G. H. H.)

"TERRESTRIAL TRIBULATION."

With the waning of the 1920 summer season, the Department of Agriculture is beset with queries, protests and anxious ones, who want to know what to do about the novel and pernicious weed pest that is playing havoc with their automobile tires, and one which, from present indications, bids fair to rank as a first-class dangerous plant pest. The offender is the "puncture vine" (*Tribulus terrestris*), late of the Sahara Desert and recorded by Pliny and others of the elder historians, and "running true to name"—it does puncture!

This weed produces numerous prostrate runners which at frequent intervals bear burs consisting of clusters of five spiny nutlets. At maturity the nutlets fall apart, always with one spine pointing upward.

By way of explanation, it should be noted that California is the land of "out-of-doors" and recent statistics show that "one of every

seven" in the state operates an automobile. Also it is notable in passing that the state is linked up by splendid highways, north, south, east, and west, making nearly every section easily and quickly available by motor, which fact commercially has aided greatly in marketing perishable fruits and vegetables in times of car shortage.

Now comes this Saharan weed, which while not having honorable mention among the Biblical "Plagues of Egypt," surely ranks first as an enemy of automobile tires in California.

One outstanding feature of its dangerous character lies in the fact that, while classed as a plant fostered and nourished by arid desert conditions, it readily adapts itself and thrives in the warm, rich valley lands of our state wherever it has located.

A good idea of the wide damage to be accomplished by this pest may be had from the recently completed survey, which shows it to be more or less widely distributed from Red Bluff on the north, through the Sacramento, San Joaquin, Antelope and Imperial valleys, to the Mexican border on the south, which constitutes in fact the main motor artery of the state.

Few automobile tires are proof against its barbs; no bicycle tire is immune to injury; and horses and live stock have suffered serious injury as a result of contact with it. Although at this date the range of this weed has been rapidly extended, it is possible still, by properly supported action and concerted interest, to inaugurate a system for the eradication of this new pest, one of the most unique in the introduced plant history of the state. (G. H. H.)

THE IMPORTANCE OF CALIFORNIA AS A BOXED APPLE PRODUCING STATE.

Few people realize the importance of California as a boxed apple state. Of the total number of cars shipped in 1919, California ranked second, the State of Washington being the only one in the Union to exceed it. According to figures recently released by the Federal Bureau of Markets, California was followed in the number of cars shipped in 1919 by Oregon, Idaho and Colorado in the order named. From the State of Washington, the most important boxed apple state in the union, 19,760 cars of apples were shipped in 1919, and of this number 2257 cars were taken by New York City and 1366 by Chicago.

The Bureau of Markets, over a period of years, has been compiling the number of carloads of the principal fruits and vegetables unloaded at the large market centers of the country. This information is very valuable as indicative of the consuming capacity of the larger terminal markets. The figures show that California shipped 4147 cars in 1919 and of that number 539 cars were unloaded at New York City, or about 76 per cent of the California apples unloaded at the ten principal market centers of the United States. It would seem, therefore, that New York is by far the most important outlet for California stock. Chicago received 66 cars of California apples in the same year, Cincinnati 31, St. Louis 24, Philadelphia 21, Pittsburgh 16, and Kansas City 12.

The following table abstracted from the Market Reporter of the Bureau of Markets, under date of June 5, 1920, gives a very accurate idea of the competition met by California apples from the other boxed apple states:

CARLOADS OF APPLES UNLOADED AT TEN LARGE CITIES.

Unloads by States of Origin for Four Years.

Originating state	New York				Philadelphia				Pittsburgh			
	1919	1918	1917	1916	1919	1918	1917	1916	1919	1918	1917	1916
Boxed Apples.												
Montana	83	23	1	0								
Colorado	2	5	3	6					14	8	3	3
Idaho	187	64	110	45	62	0	0	3	32	55	53	0
Washington	2,257	2,243	1,170	1,010	645	139	234	334	225	450	125	88
Oregon	870	551	200	171	54	3	0	3	20	33	9	4
California	539	124	147	150	21	2	5	3	16	0	3	4
All other	11	2	0	0	3	0	0	0	1	0	0	0
Totals	3,949	3,012	1,721	1,382	785	144	239	343	308	546	193	99

Originating State	Washington				Cincinnati			
	1919	1918	1917	1916	1919	1918	1917	1916
Boxed Apples.								
Montana								
Colorado								
Idaho	1	2	0	0	61	6	20	0
Washington	158	157	83	41	132	137	104	79
Oregon	28	31	11	5				
California					31	8	3	0
All other	1	0	0	0	18	4	0	2
Totals	188	190	94	46	242	185	127	81

Originating state	Chicago				St. Louis				Kansas City			
	1919	1918	1917	1916	1919	1918	1917	1916	1919	1918	1917	1916
Boxed Apples												
Colorado	162	41	107	95	79	139	86	6	44	40	110	31
New Mexico	22	0	6	8								
Utah	10	16	17	1	2	14	6	0	1	1	4	0
Idaho	242	69	163	10	62	28	128	2	73	23	49	8
Washington	1,366	490	785	676	80	162	150	133	238	265	188	280
Oregon	83	26	52	33	17	6	56	6	12	11	28	6
California	66	27	116	39	24	12	4	8	12	12	6	17
All other	2	0	2	1	0	1	1	1	1	0	2	3
Totals	1,953	699	1,251	858	234	362	391	156	381	355	387	345

Originating State	Minneapolis				St. Paul			
	1919	1918	1917	1916	1919	1918	1917	1916
Boxed Apples.								
Colorado	4	10	.1	4	------	------	------	------
New Mexico	------	------	------	------	------	------	------	------
Utah	------	------	------	------	------	------	------	------
Idaho	------	------	------	------	5	5	7	8
Washington	145	160	183	158	142	211	97	214
Oregon	1	4	5	10	2	2	0	12
California	1	1	57	0	0	0	30	0
All other	4	1	12	0	4	2	0	6
Totals	155	176	258	172	153	220	134	240

California is a more important apple state so far as volume is concerned than is Oregon, Idaho, or Colorado. This fact emphasizes the importance of proper standardization work. If our stock is going to meet the sharp competition from other states, it is essential that apples moving out of California be graded strictly according to the California standardization law, and that every car maintain the reputation of this state for quality, grade and pack.

That California will continue to be a very important factor in the shipment of boxed apples, is indicated by the statistics covering the nonbearing acreage in the state. Figures compiled by the California Development Board show that there were 690,835 nonbearing trees in San Bernardino County alone in 1919, which is more than the total number of bearing and nonbearing trees in Santa Cruz County for the same year. These figures may be taken as indicative of the nonbearing acreage in the southern California districts. Uniform enforcement of the apple standardization law will prove beneficial to the industry, and assist in obtaining fair prices for the large crops which are bound to come in ensuing seasons. (F. W. R.)

COMING EVENTS CAST THEIR SHADOWS BEFORE.

The successful application of vacuum fumigation to the control of insects affecting food products marks a step forward in matters of pest control. While as yet the field of its possibilities is practically untouched, a list of the products which lend themselves to treatment by this method covers such a broad range that an attempt to name them would in all probability place one in the ranks of a false prophet. In view of the foregoing it is sufficient to say that the question as to what place among pest control methods in the field of food products vacuum fumigation will be accorded, the coming years will answer.

(D. B. M.)

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THE LIFE-HISTORY AND SUCCESSFUL INTRODUCTION INTO CALIFORNIA OF THE BLACK SCALE PARASITE, APHYCUS LOUNSBURYI HOW.[1]

By HARRY S. SMITH[2] and HAROLD COMPERE.[3]

INTRODUCING THE PARASITE IN CALIFORNIA.

The black scale (*Saissetia oleae* Bern.) which holds first rank as an insect pest in California, is a good subject for control by the biological or "parasite" method. To our knowledge, more than thirty species of insects are recorded as preying upon this pest in various parts of the world. While some of these parasitic and predaceous insects are of great value, others are not of much economic importance and their introduction into California would prove of little benefit. Professor Charles P. Lounsbury, government entomologist for the Union of South Africa, states in a letter under date of March 30, 1912: "As I have written before, I am firmly convinced that the black scale is held down in South Africa entirely through the influence of parasites. Its abundance on the material collected for dispatch to California is due merely to the local prevalence of the Argentine ant." It is evident from observations in the past, that no single parasite or predator controls the black scale; instead there are combinations of the different forms, which by concerted action dominate the pest in given localities. To introduce the most effective species which do not occur in California, and then to make them attain their greatest efficiency by rearing and distributing them in large numbers is one of the undertakings of the Pest Control Service of the California State Department of Agriculture.

For several years the Commission of Horticulture, now the State Department of Agriculture, has been attempting to establish in California, additional natural enemies of the black scale. In this work we have continually had the active assistance of Dr. C. P. Lounsbury and C. W. Mally, entomologists for the Union of South Africa, to whom we are greatly indebted. In the summer of 1912 mention was made of rearing two hundred of what was supposedly *Aphycus lounsburyi* from material received from South Africa. It is now believed that this was a case of mistaken identity, another parasite being recorded under this name. In 1914, however, a shipment of black-scale material was received from Messrs. Lounsbury and Mally, from which we succeeded

[1]The life-history investigations recorded in this paper are the result of Mr. Compere's labors. (H. S. S.)

[2]Entomologist, Pest Control Service, California Department of Agriculture, Sacramento, Cal.

[3]Assistant, Pest Control Service, California Department of Agriculture, Alhambra, Cal.

A SOUTH AFRICAN HOST PLANT OF BLACK SCALE.

FIG. 82. From these Sparmannia trees, growing at Wynberg, Cape Province, South Africa, cuttings bearing parasitized black scales were taken. After reaching the California Insectary, the parasites were reared in large numbers and will be distributed in citrus groves to destroy the black scale. (C. W. Mally.)

in rearing a few specimens of what was unquestionably this species. The material was collected at Wynberg and Sea Point near Cape Town, and from the gardens of Cape Town itself.

THE PARASITES DETERMINED.

In 1914 some of these parasites were sent to P. H. Timberlake for an authentic determination. He replied that the parasites were undoubtedly *Aphycus lounsburyi* Howard, although fully twice as large as the types. The following is transcribed from his letter: "There is a series in the U. S. National Museum which I examined last winter and thought at first they might be distinct on account of the twice larger size, slightly exserted ovipositor, and of the ocelli being in an equilateral instead of a strongly acute triangle. The ovipositor is not exserted in the types, but they are very small specimens and wretchedly preserved. Your specimens are intermediate as the ocelli are in an acute triangle. On account of the evident variation in this species, I hope you are in a position to preserve a good series showing such variations as I have indicated. Coloration, however, is remarkably uniform."

Owing to the fewness in numbers of this parasite in the above-mentioned shipment, however, we did not succeed in establishing the parasite in the open, and it was not until we reared this same species in some numbers from material collected by the late E. J. Vosler in Australia, and applied to its propagation the recently developed method of growing the black scale on potato sprouts, that we were successful in firmly establishing *Aphycus lounsburyi* in the citrus orchards of California.

DESCRIPTIONS OF APHYCUS LOUNSBURYI.

The Adult.

The adult of *Aphycus lounsburyi* is very fantastically marked as is strikingly shown in the frontispiece. For a detailed technical description a portion of P. H. Timberlake's work is herewith given.[1]

Female—Front and vertex apparently (being much shrunken in cotypes) nearly three times as long as wide; ocelli in an acute-angled triangle, the posterior pair close to the eye margin; antennal scrobes broad and shallow; eyes nearly nonpubescent. Antennal scape about one-third as wide as long, widest just beyond the middle; pedicel as long as the first three funicle joints combined; first four funicle joints of nearly equal length, wider than long and hardly increasing in width, last two joints considerably longer and wider, the sixth a trifle longer than the fifth, both a little wider than long; club oval, rounded at apex, about one-third wider than the preceding joint and a little longer than the last four funicle joints combined. Wings uniformly ciliated; the oblique hairless streak but little wider below, interrupted, the cut-off portion separated from the basal hairless streak on the posterior margin of the wing.

Length: 0.7 mm. Front and vertex bright orange yellow; face, cheeks, and under parts pale yellowish; mesonotum dusky orange-yellow; concealed part of the occiput and the pronotum, the metanotum, propodeum, and dorsum of abdomen brown; collar of pronotum and tegulae sordid whitish; the former with a minute, blackish dot on each corner, the latter with the posterior margin pale brown. Antennal scape black with a very narrow line on upper margin, the apex and a broad band on the basal third of the lower margin white; base of pedicel, first four funicle joints and club black; apical two-thirds of pedicel, last two funicle

[1]Proc. U. S. Nat. Mus. Vol. 50, page 610. "Revision of the Genus Aphycus." P. H. Timberlake.

joints and sometimes the underside of the third and fourth joints white. Legs pale yellowish; middle tibiæ with a pair of distinct, brown dots near base, another pair at the middle, and a narrow, brown annulus at the apex; hind tibiæ similar, but the markings fainter; front tibiæ with the apical annulus faint and the two pair of dots replaced by a large but faint brownish blotch on the anterior or upper surface; last joint of the tarsi faintly blackish. Wings hyaline, the veins pale yellowish.

[Redescribed from three females (cotypes) in poor condition, reared from *Saissetia oleæ* (Bernard), Cape Town, South Africa (C. P. Lounsbury). The fourth cotype has been lost by dropping from the card point.]

"The following material also examined:

Seven females, one male reared from the same host, Cape Colony, South Africa (C. P. Lounsbury), and two females from the same host and locality (through H. S. Smith), California State Insectary No. 655ep.

The females differ from the types as follows:

Female—Front and vertex varying from twice to nearly two and one-half times as long as wide; ocelli in an equilateral triangle, or nearly so, but in three specimens in more or less acute-angled triangle, the posterior pair about one-fourth their own diameter from eye margin. Ovipositor protruded about one-tenth the length of abdomen.

Coloration nearly as in types but the front, vertex, and mesonotum uniformly dark orange-yellow, but the dark parts nearly black instead of brown; dorsum of abdomen with the lateral margins narrowly whitish posterior to the vibrissæ half way to the apex, and the anterior corners of the basal tergites invaded by the whitish of the venter; tibial bands and dots heavier and blackish and with an additional dot at the knee joint.

Length: 1.4 mm.

Male—Front and vertex a little less than twice as long as wide; ocelli in an equilateral triangle. Antennal scape narrower than in the female and the club smaller or no longer than the last three funicle joints combined. Wings as in the female, but the cut-off portion of the oblique hairless streak larger and connecting with a branch of the basal hairless streak on the posterior border of wing.

Length: 1.3 mm."

LIFE HISTORY NOTES.

Habits of Adult.

The adult parasites escape from circular exit holes cut through the dorsal region of the shell. Cutting the shell of the older scales is a slow and laborious process. The parasites effect a small hole through the shell by biting out tiny pieces with their sharp-pointed mandibles. After a hole is cut, it is slowly enlarged by cutting around the edges. When the exits are large enough to permit escape the parasites force themselves out of the old shells.

The adults are very quick and active. When an attempt is made to catch them they dodge to the underside of the twigs or hide behind the leaves, something after the manner of a squirrel in a forest which attempts to hide on the approach of an enemy. The adults do not readily take to flight but depend on their agility to escape. Although very active and shy at the approach of an enemy, *Aphycus* is a very satisfactory parasite to handle in confinement. Individuals confined in vials with sugar and water and kept in a cold place, where oviposition was prevented, lived over six weeks before they were liberated on

infested twigs. When confined in vials, the parasites need not be nursed like some of the more delicate insects. They do not easily become entangled in the syrup, and only an occasional freshening of the water is necessary.

In the field *A. lounsburyi* does not have a tendency to spread very rapidly and must be aided by man, a trait which we consider to be greatly in its favor. The parasites usually confine their activities to the individual trees in which they are liberated, providing there is a supply of scale suitable for oviposition. In many cases they will haunt the particular limb on which they are first established. Unlike some parasites, this species is particularly thorough in its work; if in sufficient numbers it will parasitize practically every scale in the area of its abundance. This parasite will develop in any black scale containing sufficient nourishment to bring a single larva to maturity. It can commence work on the small scales, beginning about the time the raised "H" is readily discernible, and continues to multiply at the expense of the pest, until the bodies of the parent scale have shriveled, after their eggs are laid. This is a very decided advantage, for it enables the parasite to propagate, stepping up its abundance uninterruptedly for almost the entire life of the host, which is normally one year. In contrast with this, there are internal parasites of the black scale which can continue their activities for only a very limited period, because the scale in its growth forms physical characteristics which render it invulnerable to the attack of certain species.

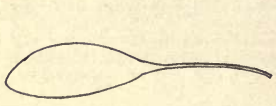


FIG. 83. *A. lounsburyi*: Egg before (top) and after (below) deposition, lateral aspect. (Original.)

When there is an opportunity for a choice, *Aphycus lounsburyi* will select the larger scales in preference to the smaller ones for oviposition. To a certain extent this also is a decided advantage, for it then first eliminates the scales which are likely to be early egg-bearers, thus prolonging the period in which it can do effective work. After the scales commence egg-laying this trait of selecting the older individuals works to a disadvantage; it disrupts the host and checks egg-laying, but the effects of the parasitism do not prevent the scale eggs which have already been deposited from hatching, thus providing for a partial new generation to reinfest the trees. The effectiveness of this parasite can not be judged merely by the number of exit holes showing in the scale. At times the older egg-bearing scale will be parasitized to an enormous extent; but the effect on the pest may be slight, owing to the fact that a hatch will occur from the eggs already deposited, despite the fact that the parent scales have been destroyed. This, however, may work to its advantage in another way, since it provides numerous parasites for the following generation of scales.

The work of this parasite is characteristic and easily distinguished. In the advanced stages of parasitism the scales become bloated, which somewhat effaces the raised "H" and their color becomes a light amber. If the scales are lifted from the twigs, the ventral tissue is seen to be taut, membraneous and somewhat translucent. The exit holes are

smaller than are those of *Scutellista* and usually there are two or more to each scale. In the case of *A. lounsburyi* the exit holes only penetrate the body cavity of the scale, while in the case of *Scutellista cyanea* Motsch. the exit holes penetrate into the egg cavity.

As is well known, many species of insects, and particularly parasitic Hymenoptera, are parthenogenetic, *i. e.*, the eggs of the unfertilized females will produce offspring. Most insects which reproduce in this way have progeny confined to one sex only, that is, they are either all male or all female. In the case of *Aphycus lounsburyi* only females are produced when the parent female is unfertilized. On the other hand, if the female becomes fertilized the progeny is composed of a proportion of males. If the species does not weaken by parthenogenetic reproduction, it would be a decided advantage if only the females are colonized, thus only increasing the individuals which are capable of reproduction. Observations extending over a long period of time, however, would be necessary in order to determine whether or not the colonization of only the females would prove to be advantageous. Cameron, who has made extensive studies in parthenogenesis, thinks that this mode of reproduction involves a constitutional weakness, fewer of the parthenogenetic young reaching maturity. This, he suggests, may be compensated for when the parthenogenetic progency are all of the female sex, by the fact that all those which grow up are producers of eggs.

D. Sharpe[1] after a review of the problem concludes:

"It appears most probable that parthenogenesis and the special sex produced by it, whether male or female, are due to physiological conditions of which we know little, and that the species continue in spite of parthenogenesis, rather than profit by it."

The studies of P. H. Timberlake on the subject of parthenogenetic reproduction of the Encyrtidae found in Hawaii is very pertinent. The following quotation is from his work[2]:

"Parthenogenesis has also played a large part without much doubt in helping the establishment of certain of our immigrant species. As a general rule it may be stated quite confidently that all Encyrtidae and for that matter most, if not all, Chalcidoidea, in so far as their habits have been investigated, are able to reproduce parthenogenetically under stress of necessity. Probably most species of Encyrtidae produce only males when the reproduction is parthenogenetic, and in case of the usual method of reproduction they reproduce in different species a variable proportion of both males and females. Before studying the habits of our local species, I had never verified the existence of any other method of reproduction among the Encyrtidae, and was surprised to find that certain of our species are regularly thelyotokus (*i.e.* produce only females) in reproduction. In *Adelencyrtus odonaspidis, Blepyrus mexicanus, Encyrtus infelix, Pauridia peregrina*, and *Saronotum americanum*, thelyotoky is the regular means of reproduction and males are rarely produced, being in fact entirely unknown in the case of *Adelencyrtus* and *Saronotum*. I have reared *Pauridia* through many generations without finding any males, and have in fact seen but a

[1]Insects: D. Sharpe. Pt. 1, p. 517.
[2]Proc. Haw. Entom. Soc., 1918, p. 195.

single male, reared by E. M. Ehrhorn several years ago. I have likewise reared *Blepyrus* through several generations and was able to find males of this species only by examining some vines at the sugar planters' experiment station [Hawaii] at a time when both host and parasite were unusually abundant. Of *Encyrtus infelix,* I was fortunate enough to rear a single male in a small series obtained in 1916, and this is the only male specimen that I have seen out of the numerous specimens examined from all parts of the world. Miss A. L. Embleton in her work on this species states that the males are exceedingly rare, only one occurring to about a thousand females. The existence of this habit of thelyotoky is obviously a great advantage to a species invading a new region, since it might become established under favorable conditions from a few females or from a single specimen. Conversely the arrhenotokous (*i.e.* producing males only) habit of reproduction may act disadvantageously before a species is well established, since the rapid dispersal which usually takes place will tend to increase the difficulties of the sexes finding each other, and thus restrict the necessary fertilization of the female."

In the case of *Aphycus lounsburyi* it was decided not to try to alter the usual mode of reproduction and both males and females were liberated. This has not affected the abundance of the parasites to any great extent, the males being very rarely met with in the orchards. We have never even observed a pair mating.

Oviposition.

This parasite gains its superiority by means of its singular method of attack, which enables it to overcome the protecting characteristics of the scale, and by means of the larval habits which permit its development in scale showing a wide variation in size. The method of attack is specialized so as to avoid the work of penetrating the tough leathery derm of the scale. The long flexible ovipositor is extended underneath the scale, and then curved upward so as to penetrate the soft ventral tissue. There is very little work prior to the insertion of the ovipositor, the female only tapping the scale with her rapidly-vibrating antennæ. The lateral margins around the rim of the scale are the points selected for the insertion of the ovipositor. When oviposition occurs, the parasite stands facing away from the scale, with the ovopositor extended underneath the rim and then curved upward so as to penetrate the soft tissue. The act is usually complete within thirty seconds and the parasite withdraws. In one scale an individual will deposit from one to twelve or more eggs, depending on the size of the host. By gluing scales to cover glasses, and then turning the glasses upside down over a cell containing a parasite, it is possible to observe the act of oviposition in detail under a binocular microscope. A strong light will render the ovipositor and abdomen of the parasite transparent, and the interior of the scale will be rendered partly visible, so that the whole performance can be viewed. When the egg is forced from the uterus into the ovipositor it is compressed to a long cylindrical form so as to pass through the channel in the long slender ovipositor. The egg is hardly recognizable as it passes through the ovipositor, for so rapid and even is the movement that it looks more like a flow of quicksilver than the

passage of an egg. The forepart of the egg, which still retains its cylindrical form, acts like a probe to penetrate some distance beyond the tip of the ovipositor into the body of the scale. Suddenly the liquid contents of the egg rush forward, inflating the anterior portion, which rises like a miniature balloon being inflated. The hind section of the egg remains tube-shaped after the contents have rushed forward. The parasite then withdraws the ovipositor, leaving the tube moulded in position, suporting the bulb or main body at one end, and the other end of the tube projecting through the integument of the host into the outer air. When the parasite withdraws the ovipositor, just as the end of the stalk issues, it gives several vicious jabs with the ovipositor. This may prove to be the means by which the end of the stalk is punctured so as to make an opening for the admittance of air.

The Egg.

The newly deposited egg is stalked (fig. 83), the bulb is elongate oval, translucent white, and with a smooth shining surface. The bulb measures .2 mm. in length, and the greatest width .08 mm. A ventral rib or stay extends about two-thirds the length of the bulb. The rib appears to be a prolongation of the stalk. This rib serves as a stay which gives rigidity when the bulb is being inflated. Immediately after deposition the stalk becomes dense white. Later when the larva hatches the stalk seems to function as an air line, and it then becomes chitinized and dark colored. The rib enters into the construction of the anal shield which forms with the larva.

The ovarian egg is quite different in appearance from the laid egg. It is a double-bodied affair, the two bulbs being divided by a long neck or constriction. The larger bulb is the main body which later contains the embryo. The smaller bulb or accessory body is an enlargement of the neck which serves as a reservoir to aid in the transformation that takes place during the passage of the egg through the ovipositor. The ovarian eggs of many parasites have an accessory bulb and connecting neck which is not transformed into an air-line for the use of the larvæ. It is supposed that this peculiar egg construction is for the purpose of making it possible to pass a comparatively large egg through a long slender ovipositor.

The First-Stage Larva.

The newly-hatched larvæ are found suspended in the body of the scale by means of a long stalk or air-line which penetrates the integument of the host. Eggs and larvæ can be located by the presence of the stalks, the tips of which project into the outer air.

The larva is composed of thirteen segments, exclusive of the head; the five posterior segments being inclosed in an anal shield, which serves to hold the larva in intimate connection with the air-line. The average sized newly-hatched larvæ measures .5 mm. in length, and the greatest width about .12 mm. The head is slighly narrower than the first segment, the body being of nearly uniform width throughout. The skin is smooth, white, and translucent. The anal shield and stalk are living organisms in vital connection with the larva, as suggested to be the case in *Microterys flavus,* which was studied by Mr. Timberlake. In this

stage two stigmata are discernible, situated on a prolongation of the two main tracheal trunks which places them in contact with the air-line. The two trunks are connected by transverse branches through the first

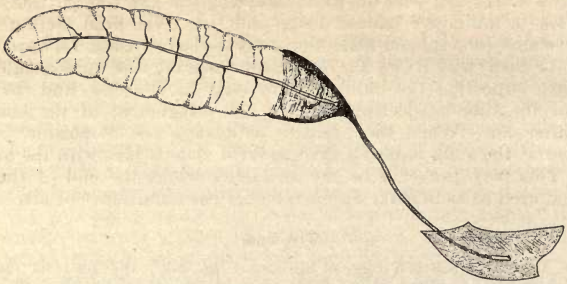


FIG. 84. *A. lounsburyi*: First stage larva, lateral view, showing stalk, anal shield, and tracheal system. (Original.)

and tenth segments. On the segments from two to ten inclusive, there arise from the trunks simple undivided branches, which extend dorsally and ventrally. Near the anterior end of the trunks simple branches extend into the head. Situated on the main tracheal trunks near the junctions of the branches on segments two, three, and four, the stigmal branches which appear in the second stage are beginning to form.

The Second-Stage Larva.

Aside from the increase in size, in this stage there is no great change in the general structure and habits of the larva. The respiratory system shows the most development, stigmata having formed on the second, third, and fourth segments; and the branches which arise from the main trunks having become so divided as to form many fine tracheæ.

The Third-Stage Larva.

Larvæ of the third stage show a marked change in their structure and habits. By this time the parasitic larvæ have consumed the liquid contents of the scale, the interior of which now becomes a dry shell.

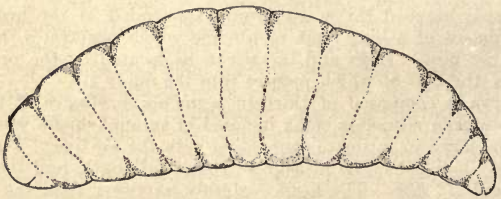


FIG. 85. *A. lounsburyi*: Mature larva, lateral aspect. (Original.)

There is a change in the method of respiration, the larvæ no longer needing to have the air piped into the scale, for now they can breathe air direct. The intimate connection with the air-line is severed, freeing the

larvæ which are now equipped with a well-developed tracheal system. There is a wide variation in the size of the mature larvæ. Measurements ranged from .3 mm. to 1.7 mm. in length, and from .6 mm. to .9 mm. in width. The body segments from 1 to 9 are larger and more distinct than are the succeeding four posterior segments which are not easily defined. The body tapers towards the head and rear. The contents of the alimentary canal fill almost the entire body cavity. The mandibles are stout with a broad base and brownish in color. On the main tracheal trunks, in addition to the dorsal and ventral branches on segments 2 to 10 inclusive, there are branches which extend to nine pairs of open stigmata. The dorsal and ventral, as well as the branches leading into the head, give rise to numerous fine tracheæ.

FIG. 86. *A. lounsburyi*: Mandible of mature larva, lateral aspect.

The Pupa.

The pupæ which are found in the dried body cavity of the host appear to be naked, and as with the larvæ they are occasionally found packed very tightly. At first they are white, later they take on the color pattern of the adult.

Generations.

The time from egg to adult will vary from twenty-eight days to three months, depending on climatic conditions. Under artificial conditions in the insectary, twenty-eight days was the minimum time for development, while in the field during the winter months this period will last for about three months.

ESTABLISHING THE SPECIES IN CALIFORNIA.

In the fall of 1919 at the Limoneira Ranch, Santa Paula, California, 53 lemon trees heavily infested with black scale were left unfumigated (through the cooperation of Messrs. Teague and Culbertson) in order to provide a propagating ground for *Aphycus lounsburyi*. The parasites were first liberated in September. Liberations of *Aphycus* followed throughout the winter months. These liberations were later supplemented by colonizations of *Scutellista cyanea* and *Rhizobius ventralis* in order to form a combination that would insure a natural control. The experiment proved satisfactory, and at this writing a new area comprising 10,000 trees has been set aside in an attempt to duplicate the performance on a commercial scale. In this demonstration *Aphycus lounsburyi* accomplished more than did *Scutellista cyanea* and *Rhizobius ventralis* combined. However, the *Aphycus* was given the advantage both in the number of individuals liberated, and by making the liberations at an earlier period.

In the city of Alhambra two other demonstration plots were selected; one, comprising two and one-half acres set to oranges, and the other having 100 trees to the plot. In both of these plots the trees were heavily infested with black scale last fall. In these demonstration plots we were not able to make any quantity liberations until April. The results were not so satisfactory, as we were more than six months

late in getting our insects in the field. This was due to the fact that the insectary was invaded by the predaceous mite, *Pediculoides ventricosus* Newport, which forced us to destroy all of our material and make a new start. *Aphycus* is however now breeding abundantly in both orchards.

To date about 30,000 *Aphycus lounsburyi* have been liberated in our various demonstration plots. They have become acclimated and are rapidly increasing, thus adding to our fauna another beneficial insect.

CONCLUSION.

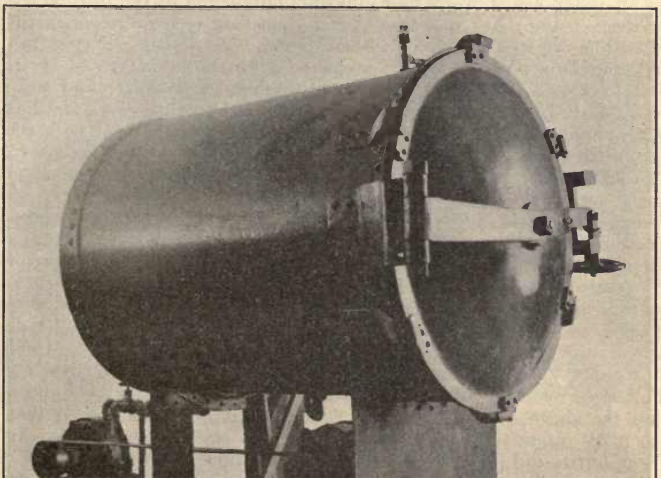
It is very possible that with the increase and spread of *Aphycus lounsburyi,* setbacks will be encountered in the way of secondary parasites, or primaries that will adapt themselves to prey upon this species. Many newly-introduced parasites have been exploited as winners, and the disappointment which followed their failures is proverbial. Efforts should not cease however until the black scale in California is controlled by its natural enemies, or the reasons for failure made clear. In the light of our present knowledge, the successful control of the black scale by the utilization of its natural enemies seems to be only a matter of time and work. If the beneficial insects which we now possess can not give the desired results in our fight against the scale, we can introduce other species from foreign lands. At this time we are engaged in trying to select the most effective exotic forms whose work will supplement that of the parasites we already possess.

The black scale problem is a serious one. A single county in California is spending over three-quarters of a million dollars annually for fumigation, the major part of which is directed against this pest. If, as is hoped, control can be brought about by the biological method as was done in the case of the citrus mealybug, it will result in the saving of many hundreds of thousands of dollars annually to our California citrus growers. However, there should be no slackening in the present methods of handling the pest until the biological method of control is thoroughly demonstrated to be practical on a commercial scale.

THE APPLICATION OF VACUUM FUMIGATION TO FRESH AND PACKED DATES.

By D. B. Mackie.[1]

During the season of 1918 reports were sent to the State Department of Agriculture of heavy losses incurred in packed dates due to the inroads of certain storage insects, with the request that the office of pest control investigate the matter and endeavor to formulate measures that would give relief. In January, 1919, the writer was detailed to make a preliminary investigation and to report on the possibility of



A Vacuum Fumigator.

Fig. 87. This vacuum fumigator was designed by the Pest Control Service of the California Department of Agriculture for the control of insects affecting dates.

remedying conditions. In a conference the date growers pointed out that for some cause unknown to them the packed dates became infested and later, when in the channels of trade, would become so wormy that purchasers returned them in disgust, a condition which in turn caused merchants to decline to handle the product. Examination of infested packages showed the dates to be heavily infested with the larvæ of the common dried fruit pest—*Plodia interpunctella* (Indian meal moth) and *Sylvanus surinamensis* (saw-toothed grain beetle). The former was decidedly the greater menace as the webs spun by the larvæ were very much in evidence, thus making the infestation immediately manifest. The beetle, being more minute, did not cause so much concern, though it was equally if not more numerous than the moth larvæ.

[1]Field Entomologist, Pest Control Service, Department of Agriculture.

The different growers and packers had been fumigating their dates with carbon bisulphide but claimed they were not getting results. An investigation proved that there were a number of factors which contributed to the poor results obtained from this procedure. These were, in general, faultily constructed fumigation boxes, insufficient exposure to fumigant, exposure to reinfestation and conditions favoring continuous infestation of packing houses.

In summing up the factors in the equation, the problem resolved itself into the development of a process of treating the finished product in order to preclude the possibility of further infestation. From previous experience with vacuum fumigation it seemed that this process offered a means of guaranteeing the destruction of the insects, but its effect on the dates was another question, and one about which the writer himself was inclined to be skeptical. While some parties put forth fantastic ideas of dire consequences which would attend treatment by this method, the writer's misgivings in this direction were engendered by the same beliefs as expressed by others less familiar with fumigants, *i. e.*, that the fruit would be so impregnated with the gas that it would be difficult or impossible to remove the evidence of it.

To make a long story short, a homemade fumigator was constructed and a series of experiments was made. In these experiments all forms of the moth and beetle, including eggs, larvæ, pupæ and adults, were subjected to treatment. Confirming previous opinion it was found that all forms of both pests could be killed by exposure to the gas of CS_2 (carbon bisulphide) used at the rate of 20 pounds per 1000 cubic feet, and injected at a 26″ vacuum for one hour. Adult beetles were killed in five minutes exposure, beetle larvæ in thirty minutes, beetle pupæ in thirty-five minutes, while the eggs required an hour. Moths subjected to the same treatment succumbed as follows: Adults six minutes, larvæ forty minutes, pupæ forty minutes, eggs sixty minutes. Since the above experiments were conducted it has been proved that with a 28″ vacuum 100 per cent kill on moth eggs can be effected by fifty minutes, and it is believed that even this time can be reduced.

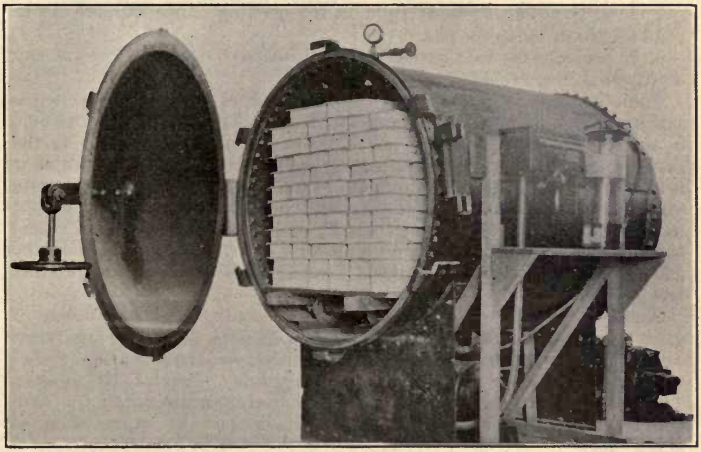
The possibility of destroying the pest having been demonstrated, it remained to work out a satisfactory application of treatment. After a number of trials it was found by a mechanical removal of the gas and a system of air washing, *i. e.*, circulating fresh air through the mass, that no trace of the gas was left in the product. As finally decided upon the treatment is as follows:

1. Load, close and lock fumigator.
2. Exhaust air to a 26″ mercurial vacuum.
3. Inject gas CS_2 until "0" vacuum is reached.
4. Expose to gas one hour.
5. Pump out gas to a 26″ vacuum.
6. Open valves and start pump, allowing free air to circulate through the mass for five minutes.

Dates taken after being processed in the above manner showed no trace of the gas even when eaten immediately upon removal from the fumigator, nor did they produce any ill effects.

Being fully satisfied with the results obtained the California Date Association asked that the office of pest control design a commercial fumigator for their new packing house. This machine, which is shown in the figures, was installed in September, 1919. In October, A. W. Risher, of the Risher Date Gardens, installed a similar apparatus to handle his pack.

It was recommended by the writer that all dates be fumigated immediately upon arrival at the packing house and also in the packed boxes the last thing before leaving. The first treatment was recom-



How The Vacuum Fumigator Works.

Fig. 88. By the vacuum process, fumigation takes place in the ultimate container, thus precluding the possibility of further infestation from an infested packing house.

mended in order to be assured that no infestation was brought into the packing house in dates coming from the field, as it had been noticed that adults of the grain beetle—*Sylvanus surinamensis*—were found on the ripe dates in the field. This practice automatically prevented a progressive infestation from developing in the packing house, and the advisability of its continuance has since been confirmed. The finished product, *i. e.*, both shredded date meat and packed fresh dates, is subjected to fumigation, the latter product being treated as shown, the last thing before being placed in cartons for shipment. If success is to be measured by the statements of those who have applied this treatment to their product, the results have been highly gratifying. Reports and statements received by the State Department of Agriculture are all to the effect that the treatment is an unqualified success. What is considered as the best evidence that can be had to substantiate this is the fact that two other firms have already approached the department with the intention of applying this treatment to the coming season's pack.

In commenting upon the comparative value of vacuum fumigation and ordinary fumigation methods, the following may be said in favor of the former:

1. The time required to treat the product is reduced from 36 and 48 hours to 1 hour.
2. The killing power of the fumigant is enhanced.
3. The space occupied by apparatus is less.
4. The fire hazard is reduced.
5. Undesirable odor of gas is largely eliminated.
6. Penetration of the fumigant is perfect throughout the mass.
7. Treatment can be made right in the packing house without inconvenience from escaping gas.
8. It provides for fumigation in the ultimate container. The gas can be injected and removed mechanically.

The possibility of treating the finished product as a trade practice is a thing which is not often appreciated at its true value. To be able to say that a product is free from insect pests is worth more to the average fruit packer than is generally believed. In regard to dates it is a very difficult matter to fumigate by the old method in the ultimate container (candy boxes), as the gas is dependent upon its own weight to permeate the parts of the pack. Provided it does enter each closed box, it then becomes difficult of removal. By the vacuum method the gas can be injected and removed mechanically, leaving the product free from any residue gas.

Another matter, of less significance generally but nevertheless of great importance in special cases—it is a custom to use in high class candy boxes more or less gilt lettering either on trade marks or elsewhere. Long exposure to CS_2 will inevitably discolor all gilding. The shorter exposure required under vacuum does not entail the danger from discoloration as in the longer method by evaporation at atmospheric pressure.

It has been a common belief that the costs incident to the construction of a vacuum fumigator are exorbitant. As a matter of fact this is not the case. One of the fumigators installed in the Coachella Valley, which is illustrated, cost—including pump, motor, fumigating drum and installation—less than $600.

The operation of a vacuum fumigator using CS_2 is very simple and does not require an especially trained operator. The apparatus at the Risher Date Gardens is operated entirely by Mrs. Risher, who received only fifteen minutes instruction in the operation by the writer.

In summarizing it may be stated that an entire season has passed since this control problem was presented to the Department of Agriculture, two fumigators have been operating continuously, and according to the packers operating them they are an unqualified success.

This successful application of vacuum fumigation to dates marks a decided step forward in the treatment of food products for purposes of pest control. In the field of dried fruit industries alone there lies an immense opportunity for the application of this method.

MISCELLANEOUS INSECT AND FUNGOUS DISEASES.

Newly Reported From Hawaii.[1]

Diseases not hitherto reported in Hawaii. So far as is indicated by the available records, the following diseases observed during the year have not been previously reported in Hawaii:

Algaroba (*Prosopis chilensis*). Black spots of pods. Pycnidial fungus similar to organism *Phoma musae* n. sp. associated with black spot of Chinese bananas. Pycnospores appendaged, measuring 10.9 by 7.3 microns. Pycnidia 145 to 165 microns, ostiole readily seen, 15 microns in diameter.

Bean (*Phaseolus* sp.). Rust (*Uromyces appendiculatus*), leaf and pod spot (*Isariopsis griseola*).

Brassica (*Sinapis cernua*), "kia choy." White rust (*Albugo candida*).

Cactus, prickly pear (*Opuntia* sp.). Blight (*Diplodia opuntiae*[?]).

Carrot (*Daucus carota*). Root knot due to nematodes.

Cotton (*Gossypium* sp.). Anthracnose (*Glomerella gossypii*).

Eggplant (*Solanum melongena*). Leaf spot (*Phyllosticta hortorum*), root knot due to nematodes.

Litchi (*Litchi chinensis*). Leaf blight due to ascigerous fungus of Glomerella type.

Peanut (*Arachis hypogea*). Wilt (*Sclerotium rolfsii*), leaf spot (*Septogloeum arachidis*?).

Rice (*Oryza sativa*). Blast (*Piricularia grisea*), stem and root disease associated with *Pythium* sp. (?).

Roselle (*Hibiscus sabdariffa*). Root disease associated with *Fusarium radicicola.*

Sorghum (*Sorghum* sp.). Smut (*Ustilago reiliana*?).

Tobacco (*Nicotiana tabacum*). Mosaic disease, root knot due to nematodes, vascular disease, Granville wilt (?).

Tomato (*Lycopersicum esculentum*). Mite disease (mite apparently the same as potato mite.

Potato (*Solanum tuberosum*). Early blight (*Alternaria solani*), common scab (*Actinomyces chromogenus*), tuber rot (*Fusarium coeruleum*), and tuber galls due to nematodes.

Turnip (*Brassica campestris*). Root scab (*Rhizoctonia* sp.), white rust (*Albugo candida*).

Miscellaneous fungous and insect pests. Among other diseases and pests observed during the year were the following:

Avocado (*Persea gratissima*). Blight (*Glomerella cingulata*).

Banana (*Musa cavendishii*). Red spider.

Bean (*Phaseolus* sp.). Anthracnose (*Glomerella* (*Gloeosporium*) *lindemuthiana*).

Cabbage (*Brassica oleracea*). Webworm (*Hellula undalis*), green cabbage worm (*Pontia rapae*), bacterial soft rot.

[1]Report of Hawaiian Agricultural Experiment Station for 1918 (1919).

Coffee (*Coffea* sp.) Sooty leaf mold (*Capnodium* sp.?).

Corn (*Zea mays*). Leafhopper (*Peregrinu maidis*); motling disease similar to yellow stripe disease of corn, cause undetermined.

Guava (*Psidium guajava*). Russeting due to red spider.

Litchi (*Litchi chinensis*). Erinose, *Eriophyes* sp.

Mango (*Mangifera* sp.). Blight (*Glomerella cingulata*).

Monterey cypress (*Cupressus macrocarpa*). Roaches.

Onion (*Allium cepa*). Thrips.

Potato (*Solanum tuberosum*). Tuber moth (*Phthorimæa operculella*), wilt (*Fusarium oxysporum*), tuber rot (*Fusarium oxysporum* and *F. radicicola*), and rosette (*Rhizoctonia* sp.).

Pineapple (*Bromelia* sp.). Bud rot (cause?), wilts of several types apparently not caused by parasitic organisms but suggesting malnutrition.

Taro (*Colocasia* sp.). Root rots of several forms, a specie of Pythium (?) associated with most common type.

Tomato (*Lycopersicum esculentum*). Blight (*Phytophthora infestans*).

A TERMITE PEST OF VINEYARDS.

By R. L. Nougaret,[1] Sacramento, California.

Recently, termites, commonly called white ants, have been discovered in the vineyard districts of Merced County attacking young vines.[2] It is seldom that this insect attacks living tissue, but in the case of injury to young vines, it is due to the great number of termites originating from pieces of stalk of the *Arundo donax*, used in setting out vineyards instead of the small pieces of laths or other wooden sticks commonly used for this purpose.

The *Arundo donax* is a plant quite different from bamboo, but in its appearance and the manner of growth it resembles the latter. It grows as a long stalk, with long narrow leaves produced at each joint, and

A Source of Termite Danger.

Fig. 89. The hollow-jointed canes of this plant (*Arundo donax*) furnish shelter for the "white ants" or termites, which later caused damage to vineyards in the Merced District.

attains a height of fourteen to sixteen feet. It is grown in rows along ditches to serve as windbreaks. It is a very vigorous grower, requiring no cultural care,[3] very little attention is given to the windbreak once growing well. Broken stalks are allowed to lie where they fall; they dry out and being hollow in the center, provide an excellent breeding place for the termites above mentioned.

[1]In charge, Viticultural Service, California Department of Agriculture.

[2]Arthur E. Beers, Horticultural Commissioner of Merced County, first noticed these conditions and brought them to the notice of the writer. The following notes are the results of an investigation which followed.

[3]New shoots every year sprout up from the roots. These keep reaching out into new soil and the canes increase in numbers very rapidly. After a short period of years, a single row of roots set out along a ditch bank has become of considerable width and forms an excellent windbreak quite difficult to penetrate.

This species of termite has been determined by Nathan Banks as the *Reticulitermes hesperus*, a very common species species throughout California; in view of this fact it will be necessary to more carefully clean up the rows of windbreaks of all broken pieces of cane if this insect is to be kept under control than were it a species introduced from Europe with the plant, and the latter being a special host. If this is not done these termites may become a serious pest not only in respect to young vineyards but to dwellings and wherever lumber is used.

DISTRIBUTION MAP.

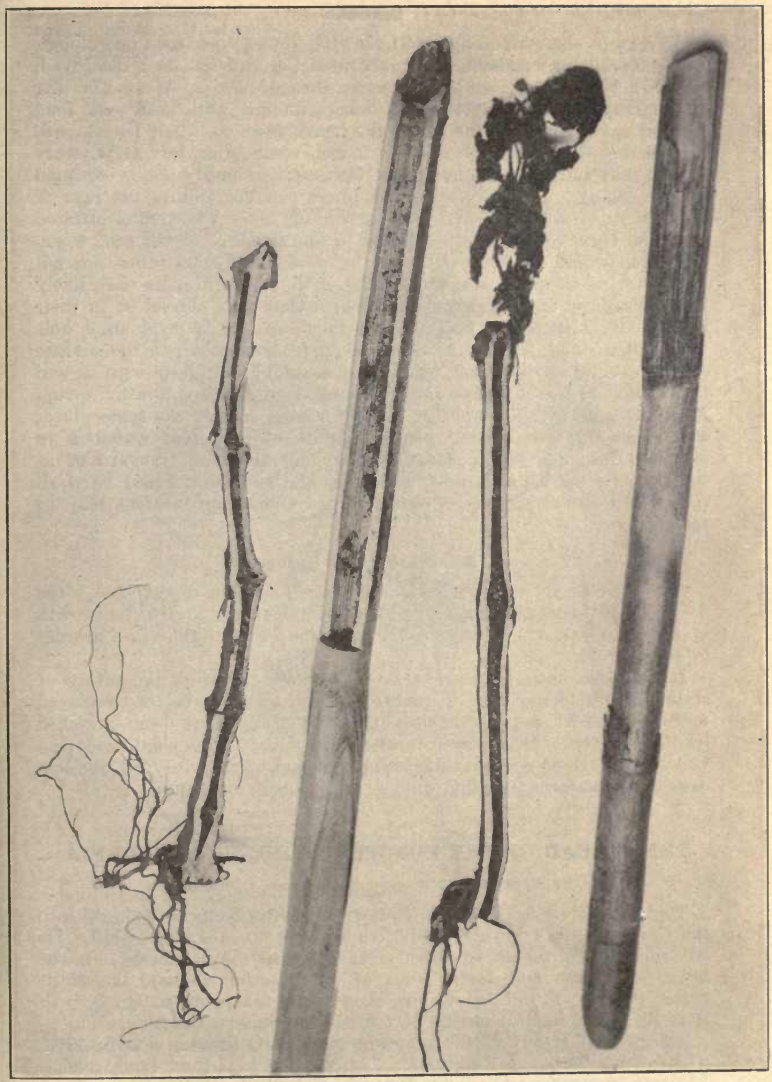
FIG. 90. As will be noted above, the white ant, *Recticulitermes hesperus*, is widely distributed on the Pacific Slope. (Snyder and Banks.) U. S. Nat. Mus.

The injury to the young vines is caused by the termites breeding in great numbers in the pieces of stalk and leaving the latter, due to overcrowding. They find their way to the young vines and attack them under ground, gaining entrance at the lower end where the roots originate. They bore up through the pithy substance of the vine, gnawing through the nodes and destroying the pithy fibre and attacking the live tissue surrounding it. In this way a long, empty tubular space is produced throughout the whole length of the trunk, in which mold and decay is started by moisture ascending from the soil.

LIFE HISTORY AND HABITS.

According to Nathan Banks *Reticulitermes hesperus* is a new species. As we have no data at hand relating to the biology and habits of this species we will give under this heading only some general characteristics common to this group of insects.

The termites though commonly called white ants belong to a different entomological order than the latter. They have however some analogy to the ant in the social habits of both. In the colonies of termites are found three distinct forms—the worker and the soldier, which are wingless and are found in the colony at all times, and the sexual form, comprising both male and female. They appear for a short period of time only and have wings while swarming, which they drop shortly afterwards. From the sexual females is produced the egg-laying queen who provides the eggs for the colony. The workers and soldiers are undeveloped individuals of the sexual form. They attend to all the duties of the colony, besides which the soldier defends it from intruders. The winged termites are migrants capable of becoming founders of new colonies. These, however, are generally formed by the splitting up of old ones, when these become too populated or the extending of their galleries reaches more favorable conditions of food. Termites feed on decaying vegetable matter, moistened wood and even bore their galleries into timbers. Living fibrous tissues are rarely attacked.



TERMITE DAMAGE TO YOUNG GRAPEVINES.

FIG. 91. Damage to young grapevines in the Merced District, by the termite, *Reticulitermes hesperus*. The colonies, propagating in the canes, utilized to "stake" young vines, destroy the pith.

Control.

As may be observed in figure 91 showing young vines split open longitudinally, the soft substance or marrow of the vine has been destroyed, the harder fibrous section or node eaten through, the cavities containing the marrow widened by the walls being attacked, and finally one long tubular space left from the top of the trunk down its whole length with an opening into the soil, but with a thin obstruction left at the very top so that sunlight can not penetrate into the empty space occupied by the colony. The workers and soldiers can not endure the rays of the sun, their soft bodies rapidly shriveling up. Vines thus infested have the heart of the trunk exposed to the moisture of the soil, which will cause mold to form, followed by decay. If such vines are not killed during the early stage of their growth, they will more than likely have become weak and nonprofitable at a time they should be in their prime. It is therefore best to pull them up, dig a good sized hole where they stood, scatter the earth taken from it out upon the surface of the ground so that any termites that might be mixed with it will be exposed to the sun rays and thus destroyed. The following spring it will be safe to plant another healthy rooted vine in the same place; and above all, avoid using pieces of stalk of the plant which is an excellent host for the termites to stake out the new vineyard or as props to tie up young vines. Clean up the windbreaks and burn all pieces of dead stalks; by so doing future serious infestations may be forestalled.

Damage Not Yet Serious.

Although as yet no very serious damage has been reported of vines dying, still this condition is apt to interfere seriously with the growth of the vines and the future crop production, even if the vines are not killed outright.

It has also been noticed on several occasions, when the pieces of stalks set out temporarily in planting the vineyard have been replaced with permanent redwood stakes, that the latter have been attacked by the termites. It is easy to understand that if these conditions prevail to any extent necessitating restaking part of the vineyard, the loss caused by the termites might amount to a considerable sum.

THE SPREAD OF THE PUNCTURE VINE IN CALIFORNIA.

By Ethelbert Johnson,[1] Sacramento, California.

The puncture vine, *Tribulus terrestris*, was probably introduced into the United States from the Mediterranean region in ships' ballast. Its advent into California is directly traceable to the railroads. In the hot dry climate and fertile soils of our interior valleys, the plant seems to have found conditions even more favorable to its growth than its native habitat on the borders of the Sahara Desert.

The earliest report of the puncture vine in California was in 1903, when it was found growing along a railway bank at Port Los Angeles. In 1908 it was found in abundance in the Southern Pacific yards at Colton, and was also collected near San Bernardino. In 1912 it was

[1]Technical assistant, California Department of Agriculture.

reported as a troublesome weed in the vicinity of Bakersfield. It has now spread over a large area in the upper San Joaquin Valley and is found in a nearly unbroken line along the railroads northward to San Joaquin County. In the Sacramento Valley, it has been found at Woodland, Durham and Marysville, and is reported as widely spread along the railroads in Tehama County.

South of Tehachapi, the puncture vine is found from the Mexican border through the Imperial and Coachella valleys to the coastward

THE "PUNCTURE VINE" (*Tribulus terrestris*).

FIG. 92. This weed produces numerous prostrate runners which at frequent intervals bear burs consisting of clusters of five spiny nutlets. At maturity the nutlets fall apart, always with one spine pointing upward. The burs shown in the illustration are actual size.

valleys of Riverside, San Bernardino, Los Angeles and Orange counties.

From the rapidity of its spread in the upper San Joaquin Valley in the last ten years, it is to be expected that the pest will continue to extend its limits from these newer centers of infestation until something is done to check it.

The plant produces numerous prostrate stems which frequently grow to a length of eight feet. At every joint is produced a number of burs, usually five, which separate as soon as they mature. Each bur possesses two or more sharp spines about the size of carpet tacks, so disposed that however the bur may fall, one spine will always point upward. These spines will pierce an automobile tire the tread of which is somewhat worn, and will readily puncture a bicycle tire.

The weed threatens not only the motorist, but the farmer as well, since it invades pastures, hayfields and cultivated crops, and is capable of inflicting severe injuries upon all classes of stock, especially horses, by piercing the frog of the foot. Intensive farming practices will keep

DISTRIBUTION OF THE "PUNCTURE VINE" (*Tribulus terrestris*) IN CALIFORNIA.

FIG. 93. Note the rich interior valleys of the state are involved; and the trend of distribution follows the line of the railroads.

cultivated lands free from weeds, but the real problem of the puncture vine is its control in waste land and along roadsides and railroad rights of way. It is important that the people of the state be alive to the urgent necessity of curbing the spread of this vicious pest to the end that they may demand that adequate measures be taken to check it.

ARGENTINE ANT CONTROL FROM AN ECONOMIC STANDPOINT.

A. F. SWAIN,[1] Riverside, California.

INTRODUCTION.

During the past few years the Argentine ant (*Iridomyrmex humilis* Mayr) has become a very serious pest in many of the southern California citrus districts. In fact from a financial standpoint, where uncontrolled it is one of the most serious of our insect enemies. It was only a dozen years ago that it was first observed in California. In 1910 Woodworth[2] stated in regard to the southern California infestation:

"Recently discovered colonies in and about Los Angeles place that district well toward the front in the amount of infested territory, and

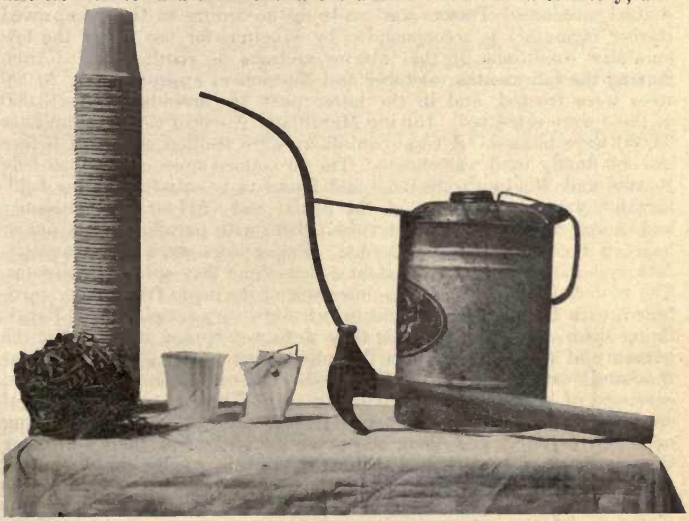


FIG. 94. Materials used in setting out "poison bait" for the Argentine ant.

five small colonies[3] in the neighborhood of Riverside complete the enumeration of the points of distribution at present known and mapped."

At the present time there are several hundred acres, or more correctly a few thousand acres, in the Riverside district that are infested. This past season some 500 acres belonging to the National Orange Company alone were heavily infested. The degree of infestation may be realized when it is known that when one walked through an orchard

[1]Entomologist, National Orange Company, Riverside, Cal.
[2]Woodworth, C. W. The Control of the Argentine Ant. Calif. Exp. Station Bull. 207, October, 1910.
[3]The italics are the writer's, not Professor Woodworth's.

and accidentally brushed against the leaves of a tree, hundreds of ants rushed onto him. Inspection work was not the most pleasant of occupations because of the abundance of the ants. Men working in the orchards had to keep their lunches in watertight containers, placed in irrigation flumes, to keep the ants out. One day some men tried the plan of hanging their lunch baskets on a wire midway between two trees, but to no avail for the ants crawled out the wire and down into their baskets.

CONTROL.

When the writer took charge of the insect control operations for this company in August of last year, the ants were extremely abundant and troublesome. Men had threatened to leave because of the presence of the ants in their homes. Consequently it was decided to inaugurate control measures. Poison was made up according to the "Improved Barber formula" as recommended by Woglum for use under the low humidity conditions of the interior sections of southern California. During the fall months (October and November) approximately 20,000 trees were treated, and in the latter part of November some 13,000 of these were retreated. During March and April of this year another 33,000 were treated. Several containers were studied and tried before the one finally used was chosen. The two-ounce spice cans as used by Borden and Woglum were tried and found to be satisfactory for holding the syrup, but because of the initial cost ($17.50 per thousand) and the labor necessary to waterproof them with paraffin and to punch holes in them they were discarded. Paper bags were found unsatisfactory because of the fact that in a short time they split at the seams. The writer obtained a few two-ounce spice cans made from heavy cardboard, with tin tops and bottoms, which were very satisfactory. Paraffining them was unnecessary as they were waterproof already, but the necessity of punching holes in them and their initial cost ($22.50 per thousand) caused them to be discarded. The container finally adopted consisted of a pressed paper drinking cup. These cups were made of one circular piece of paraffined paper pressed into shape. There being no seams to burst and their cheapness (slightly less than $5.75 per thousand) together with the ease of handling a goodly supply caused their final adoption. These cups fit one into another, so that the operator could carry a large number of them conveniently. In fact each operator would start out with a box of 100, the box being 3″ x 3″ x 18″. Their main drawback was that they were open at the top, allowing rain to enter them during the winter. If they had to be refilled in the spring a large percentage of them had to be replaced. However, their slight cost permitted this with a less expenditure than with the spice cans.

The operation as carried on was as follows: Each operator was supplied with 100 cups in a box, a small amount of excelsior in one pocket, a few ¾-inch roofing nails in another, a small hammer, and a can of poisoned syrup. The cans used to carry the syrup were the ordinary gallon kerosene cans, in which a long spout (about fifteen inches in length and a quarter of an inch in diameter) led from the bottom rather than from the top of the can. This permitted the cups to be filled easily after having been tacked onto the trees. This gallon can

would hold enough syrup to fill one hundred cups. The first operation was to place a few strands of excelsior in a cup, the top was then folded over longitudinally, a nail put through it near the top, the cup tacked to the trunk of a tree, and then filled with the syrup up to the nail. In this manner each operator after a day's practice was able to place from 40 to 50 cups an hour, or 350 to 400 a day. Labor cost $3 per day, resulting in less than .01 per tree. The cost of the cups, nails and excelsior was about .0065 per tree. As made up the poisoned syrup cost approximately 80¢ per gallon, or .008 per tree. The complete cost of treating 53,000 trees and refilling cups on 13,000 of them was $1,428, or about .024 each.

The syrup was made up in 20-gallon quantities according to the following formula:

12½ gallons water, in which was dissolved
2 ounces of tartaric acid. This was heated to almost the boiling point and then
100 pounds of sugar was added slowly and well stirred until dissolved, and then allowed to boil for one hour. After this cooled
6 ounces of sodium arsenite, dissolved in a few pints of lukewarm distilled water, were added, and finally
20 pounds of strained honey and
4 ounces sodium benzoate, previously dissolved in a little water, were stirred into the solution.

It was found after some experimenting that a cheap grade of honey, the socalled "baker's honey," was as satisfactory as a higher grade product, provided that it was boiled and strained properly. This necessitated a slight additional labor, but the difference in price between this low grade honey at 10¢ a pound and the higher grade product at 22¢ to 25¢ a pound more than repaid the additional labor cost. If the honey used is not strained, it will cause a crystalization in the syrup. In fact it is necessary to boil it several minutes before straining to prevent crystalization. It was further found that at least one hour's boiling of the syrup was necessary to insure against a souring of the product later. Even this long a boiling of quantities of one or two gallons was not a complete insurance, and even the adding of a small amount of benzoate of soda did not overcome it entirely. It is probably due to the great amount of heat necessary to cook such large quantities as 20 to 25 gallon lots that prevented later souring. One other point brought out by this work was the fact that sodium arsenite known as "technically pure" gave as good results in the field as the "chemically pure." However, the writer would not care to recommend the use of this product, nor would he use it if "chemically pure" sodium arsenite is available.

RESULTS.

As stated above, 20,000 trees were treated during the months of October and November, and 33,000 during March and April. All orchards (with one exception noted later) were fumigated during the season of September to January. The treatment last fall followed immediately after fumigation. At that time, therefore, there was a minimum of natural feed for the ants inasmuch as the scale had been cleaned up by the fumigation (through the whole acreage there was 100 per cent cleanup on the scales present). Furthermore at that

season of the year aphids are very scarce in this section, and could not furnish feed for them. Within two weeks after the poison was placed on the trees no ants could be found, nor did they return at any time during winter, even when there were several very warm days. At the present writing, a few ants can be found here and there, but for all practical purposes the cleanup has been 100 per cent efficient. Furthermore, the present season is far enough along now so that another treatment will not be necessary. This shows that one treatment is sufficient for at least two seasons. That brings the cost to only .012 per tree per year.

Barber[1] recommends the spring as the best time for treatment for it is with the advent of warm weather that the large winter colonies are broken up and, according to him, at that time food is at its minimum. Woglum and Borden[2] recommend either a spring or a fall treatment—in the spring time because of the breaking up of the winter colonies, and in the fall because the cold nights make the ants more or less sluggish. The writer observed that during May this year the majority of the winter colonies were being broken up. However, in the spring time there is always present a greater or less amount of weeds and grass in orchards, because of the fact that the orchards are not cultivated thoroughly during the winter. These weeds and grasses harbor aphids, which in turn furnish food for the ants. In the fall aphids are not at all abundant in or about orchards, and this, together with the sluggishness of the ants due to the cool nights, make this season of the year the most satisfactory for attempting control. The results of poison placed out during March and April this year are not so striking as that placed during November and October of last year. However, the results are good, and while the writer feels that the best time for control is during the fall months, if for any reason this is not possible, the spring will do very well.

SOME ECONOMIC CONSIDERATIONS.

It is without question possible to so reduce the numbers of ants in orchards that their presence is unnoticeable, as has been proven by the work of Woglum and Borden[3] at Uplands, California, and by the writer's work here reported. However, in spite of the work by Woglum and Borden which has been brought before the citrus growers of the south, it is still believed by many orchardists that the Argentine ant is of little or no importance to them. To tell an orchardist that the ants protect mealybugs and scale insects is all well and good, but the average man does not pay much attention to it. Show him a comprehensive demonstration as that of Woglum and Borden in Uplands or of the writer in Riverside, and then give him actual figures as to costs and money saved, and he will be awakened.

In 1917 a period of extreme heat had such disastrous results on the black scale in this locality that even now there is but very little present, and fumigation for this pest has been practically abandoned for the past three seasons. However, the soft brown scale survived the heat better and at present wherever the Argentine ant is present in this

[1]Barber, E. R. The Argentine Ant. Distribution and Control in the United States. U. S. Dept. Agri. Bull. 377, August, 1916.
[2]Woglum, R. S. and Borden, A. D. A Comprehensive Demonstration of Argentine Ant Control. The California Citrograph, Vol. 4, No. 6, p. 147, April, 1919.
[3]*Op. cit.*

locality the soft brown scale is abundant. Quayle[1] wrote concerning this insect, that "while seldom occurring in injurious numbers over an entire orchard, [it] often severely infests an occasional tree or portion of a tree, but the infestation is usually of short duration, due, in most cases, to the efficient work of one or two parasites." This is very true outside the territory of the Argentine ant, but it is decidedly not so in the Riverside district at the present time. It was necessary for the writer to have over 200 acres fumigated last fall for this pest alone, and undoubtedly due entirely to the Argentine ant. Here is an item of over $6,000 to be charged against the Argentine ant, not taking into account the loss in value of fruit through a lowering of its grade due to smut. This one item of expense, the fumigation of 200 acres, more than covers three times the entire cost of ant treatment of over 500 acres.

Whether the ants could have been so efficiently controlled with the scale present in large numbers was a question in the writer's mind until a short time ago. As it so happened there was one ten-acre block of Washington navel trees which were heavily infested last fall with both the soft brown scale and the Argentine ant. Due to pressure of other work this block was not fumigated, although the ant poison was placed on the trees. No inspection of the block was made until a few weeks ago, and the writer was both surprised and pleased to find that the ants were entirely cleaned up, and furthermore a half hour's search did not bring to view a single living specimen of the soft brown scale. Another block of Washington navels adjoining some of this company's property was heavily infested last year with both the ant and the soft brown scale. Some poison was given the owner who placed it on the trees last November. The results there are the same as in the orchard just mentioned. This proved conclusively to the writer that the ants could be controlled even when the soft brown scale was abundant, and ant control resulted in scale control. Which is cheaper, .024¢ per tree for ant poison, or 30¢ to 40¢ per tree for fumigation, with ants still present after the later process?

Woglum and Borden[2] pointed out how the Citrophilus mealybug was controlled in the Uplands district through the control of the ants. A portion of a 15-acre block of Washington navels belonging to this company has been infested to a small degree with this mealybug for the past two or three years. Each year it has spread slightly. However, ant poison was placed on the trees last fall, and twice bands which were on the trunks of the trees were removed and washed in kerosene and the tree trunks washed with 15 per cent kerosene emulsion with the result that at present not more than a couple of dozen trees are infested with the mealybug, and on these only a very few could be found. A lemon orchard adjoining this block has been treated for the mealybug regularly every few weeks, the bands being removed and washed and the tree trunks scrubbed with kerosene emulsion, yet the mealybug is very abundant. No attempt has been made there to control the ants.

There is another point to be considered on which no previous investigator has seemed to touch in regard to the Argentine ant, that is, its

[1]Quayle, H. J. Citrus Fruit Insects. Calif. Exp. Station Bull. 214, May, 1911.
[2]*Op. cit.*

effect on labor. It is true that the ants have no "sting" nor do they "bite" one, but it is rather annoying to have them crawling over one's face and hands and down his collar, and feeding on his lunch. And this is exactly what they do. To such men as pickers and pruners they are a very serious pest. Considerable loss is realized through the inefficiency of labor due to the presence of the ants—both in lost time fighting them off, and in lost time breaking in new men to replace those who refuse to work under such conditions. A very conservative estimate of the loss of efficiency on this company's orchards is 15 per cent. That means if it takes 20 men 10 days to pick the fruit on a given block where the ants are not present, it will take over 11 days to pick the same block if the ants are at all abundant. At $3 a day per man, this means an additional cost of about $70 a day. With a picking crew of 20 men working six months of the year, the additional cost for labor due to a loss of 15 per cent efficiency amounts to approximately $1,000. Add to this 20 more men working on the average of 200 days a year in various orchard operations, as hoeing weeds, irrigating, pruning, and so forth, and an additional cost of about $1,400 is realized. There is then a loss of about $2,400 a year due to the effect of the ants on labor. Ant control cost $1,400 and is good for at least two years and possibly three, which means a saving in the one item of labor alone of over $1,500 a year. Consequently if the relationship of the ants to the scale insects and mealybugs is not considered, the cost of treatment is more than warranted by the saving in labor costs.

CONCLUSION.

It has been demonstrated that the Argentine ant can be controlled under citrus orchard conditions in southern California, this costing less than 2½¢ per tree per year, possibly only 1¼¢ per tree per year. The ant is a prime factor in the Riverside district in the abundance of the soft brown scale and has necessitated the great expense of fumigation, which is several times greater than the cost of ant control. It is also a prime factor in the abundance and spread of the Citrophilus mealybug, which is potentially a very serious orchard pest. The loss in efficiency of labor due to the ant is greater than the cost of ant control.

THE DANGER OF INDISCRIMINATE INTRODUCTION OF FOREIGN PLANT VARIETIES.

By I. WILKANSKY,[1] Jerusalem, Palestine.

The introduction of foreign varieties of plants used to be considered by our farmers in Palestine as a sign of progress and scientific management. Everybody tried to introduce something foreign, seldom stopping to consider whether it was worth while or whether the foreign was not inferior to the native variety.

I am going to cite a few facts which will show how extremely cautious one has to be in introducing foreign varieties of plants.

Our first European experts having rather naturally assumed a superior, disdainful attitude towards our native agriculture have also treated with contempt the native varieties which have grown in Palestine for thousands of years and have thoroughly adapted themselves to the local physical factors.

One of their first acts was to introduce French varieties of olives, though we have had five good native varieties of oil producing olives. The Jewish farmers of Palestine saw something quite revolutionary about it—the trees looked different and their fruit was large—and they proceeded to imitate and grafted their trees to the new, imported varieties. But before the trees had come to bearing they were found to be infested with boring beetles (*Himatismus villosus* and *Phloeotribus oleae*) and the olive fly (*Bactrocera* [*Dacus*] *oleae*). Only the foreign varieties were infested; the native ones were free from these pests. The growers had to dehead trees as old as twenty years or more and regraft them to the native varieties.

At present our Jewish olive growers carefully avoid taking grafting stock from our olive groves, in spite of the fact that our olive groves are much better than the groves of the native fellahin (peasants) for fear that they may stumble by mistake upon some imported, foreign stock. Grafting stock is therefore taken from the groves of the native fellahin in which only native varieties of the olive may be found.

In the experimental farm, Ben Shemen, of which I have been in charge, I had the following happen to me. In my olive nursery I insisted upon using grafting stock derived exclusively from the famous olive forests of Lydda and Ramleh, in the foothills of Judea. The varieties of that district are called Rumi, hinting that they were planted by the Crusaders. Later however I discovered that a portion of the nursery was grafted with stock which was brought by a Jewish farmer from one of our colonies where French varieties of the olives were still grown. A grove was planted with stock from this nursery. Up to the bearing age of the trees nothing uncommon was observed in the growth of the trees, but on the eighth year, the olive fly broke out in the grove.

Prior to this I never had observed the olive fly in Palestine. But I remembered it very well since a tour in Italy. There I saw hordes and hordes of flies covering the piles of olives gathered in their storehouses. In the restaurants when olives were served, my companion, an Italian

[1]Director of Agriculture of the Zionist Commisson, Jerusalem, Palestine.

horticulturist, would cut the olives open to show me the galleries and labyrinths made by the fly in the meat of the olive. Olive after olive he would cut open and every one of them would invariably show these characteristic labyrinths. I knew that in Italy the olive fly was considered one of the greatest pests known and that the best of Italian entomologists were devising means to combat it. Prof. Berlese was distributing at that time in the olive groves of Italy baits of molasses and arsenic, placing the pots among the branches of the trees.

And here I had the same "problem" before me. Was it possible that I failed to observe this pest in Palestine until it affected my own trees? I immediately proceeded to inspect carefully the old native groves located within a mile or so of the farm in my charge. Not on one tree grown on those thousands of acres have I discovered a trace of the pest. I showed olives affected with the fly to the owners of those groves—no one of them had ever seen it before. I visited our Jewish colonies—none of the trees grafted to native varieties was affected. Only in one small grove I found the olive fly. The owner wanted to produce a Provence variety and he did not graft his trees to a native variety.

Nor do the boring insect *Himatisms villosus, Phlocotribus scarbeoides* and *Hylesinus oleiperda* attack the native Palestinian varieties, the wood of the native varieties being firm and hard while that of the French varieties is tender and soft.

And if we compare the yields of the native varieties with those of the foreign ones, we shall see that they are inferior neither in quality nor in quantity.

It is obvious, then, that in this case it was inadvisable to introduce foreign varieties. But even if the foreign varieties were superior, it is still very questionable whether it would pay to sacrifice the great resistance and peculiar adaptation of the native varieties for the sake of superiority in other respects.

Therefore extreme vigilance and careful judgment should be exercised when it is proposed to introduce foreign varieties. In general it is best to leave the matter of introduction from foreign countries in the hands of specialists and experts on the staff of introduction gardens, they being best qualified to exercise all the vigilance and judgment required.

A RECENTLY DISCOVERED CITRUS PEST, PLATYNOTA TINCTANA (WALK.) IN CALIFORNIA.

By R. S. Woglum, U. S. Bureau of Entomology.

INJURY TO ORANGES BY WORMS.

Injury to oranges from short burrows in the rinds, frequently the forerunner of decay, is familiar to most packing-house managers and to many growers in southern California. These burrows or tunnels, each with a small exit, for the most part open but sometimes partly filled with web, have generally been attributed to the orange tortrix (*Tortrix citrana*). No other tortricid larva appears to have been recorded as injuring citrus in this state, although several species have been reported as minor pests of the orange in Florida.

REARING WORK AT ALHAMBRA.

In 1915, some oranges and lemons attacked by lepidopterous larvæ were collected at Alhambra and placed in rearing cages. The moths which emerged differed greatly from the orange tortrix (*T. citrana*) and proved to be identical with specimens reared in July, 1913, from larvæ collected in citrus nursery stock at Whittier. This same species did considerable damage during the spring of 1915 to the young growth of citrus nursery stock on the laboratory grounds at Pasadena by rolling up or binding together and destroying the tender bud leaves. Specimens of these moths submitted at that time to Dr. H. G. Dyar of the U. S. National Museum, were identified as *Platynota* sp., and more recently August Busck determined material from the same lot as *Platynota tinctana* Walker.

OUTBREAK OF ORANGE WORMS IN 1916.

A severe outbreak of orange worms occurred during the autumn of 1916 in the Alhambra-Pasadena district, causing a heavy loss of fruit. This outbreak was reported by Quayle[1] who attributed the injury solely to the orange tortrix. The writer, however, made a careful study of the situation at that time and collected many larvæ and infested fruit in orchards suffering most severely. The moths which emerged proved to be partly *Tortrix citrana* and partly *Platynota tinctana*. More recently (1919) reports of severe tortrix injury in Orange County led to an investigation of fruit conditions in packing houses and orchards with the result of proving the damage to be due to both species of orange worms. The orange tortrix, however, predominated at the time of the inspection in August.

SIMILARITY TO PLATYNOTA.

This pest appears to be identical with specimens of Platynota which were highly destructive to carnations, asters and chrysanthemums at Hollywood in 1913 by destroying the buds, webbing together the leaves or eating into the stalk. The moths have frequently been observed

[1]California Citrograph, April, 1918, p. 133.

about lights both at Pasadena and Alhambra at times when a careful search of the nearest citrus trees failed to show evidence of infestation. In a letter enumerating the known food-plants of this insect August Busck states that "the species of Platynota are all general feeders and that orange is only one of the food-plants of *Platynota tinctana* Walker. In fact I have it in the collection from various greenhouse plants and from cotton and carnations."

DESCRIPTIONS.

The adult—The adult is a rather small moth, with pointed head and somewhat heavy forewings which, when folded, form a rooflike ridge over the body. The females are a variable grayish-brown with a faint indication of an oblique darker colored band on each wing. They average slightly less than half-an-inch long with folded wings. The males are fully one-third smaller than the females, somewhat darker and the surface of the forewings is roughened with elevated tufts and ridges of coarse scales. This tufted and ridged condition of the male forewings, their darker color and conspicuously smaller size, readily distinguishes the adult of the orange webworm from the cinnamon-colored smooth-scaled, V-banded orange tortrix.

The egg—The eggs are deposited upon the surface of leaves in patches of transparent yellowish-green color, each egg overlapping another after the manner characteristic of this group of insects.

The larva—The larvæ are dark colored with a conspicuously black head. This coloration readily separates them from the greenish-white larvæ of orange tortrix.

HABITS OF THE LARVA.

When present on fruit-laden orange trees the larvæ are usually found webbed within old dried leaves or fallen flower petals close to the fruit, or even webbed against the fruit itself. Not infrequently they lurk in the protection of touching fruit, especially if in large clusters. The fruit is damaged through puncturing of the rind. The orange webworm does not appear to confine itself within the burrows in the fruit so closely as does the orange tortrix, nor does its burrow usually penetrate so deeply toward the rag.

PARASITES OF ORANGE WEBWORM.

The worm and pupa are highly parasitized even as is the orange tortrix. At least three distinct species of hymenoptera have been reared from the larvæ and pupæ, including two internal species and one ectoparasite. These parasites appear able to control the pest except on occasional years. An example of the rapidity with which natural control may occur is well shown by the history of an infested orchard in Orange County. Worms had been abundant in the spring and were numerous in August. Specimens collected during this latter month were heavily parasitized. An examination the following May failed to reveal a single worm and evidence of injury to the new crop of fruit was difficult to find.

DISTRIBUTION.

Mr. Busck gives the distribution as the west coast of the United States extending down into Mexico and Central America.

The apparent wide distribution of this newly recorded orange pest and its diversity of hosts portends a recurrence of its attacks to oranges from time to time even as has been the history of the orange tortrix. The writer's studies, however, lead him to believe that the pest will prove less injurious than the tortrix.

SEED PRODUCTION OF THE CANADA THISTLE IN SOUTHERN CALIFORNIA.

By ETHELBERT JOHNSON,[1] Sacramento, California.

The Canada thistle, *Cirsium arvense,* is a weed pest with an exceedingly bad reputation which is not yet widely distributed over California. Patches of it are found, however, in Orange and San Bernardino coun-

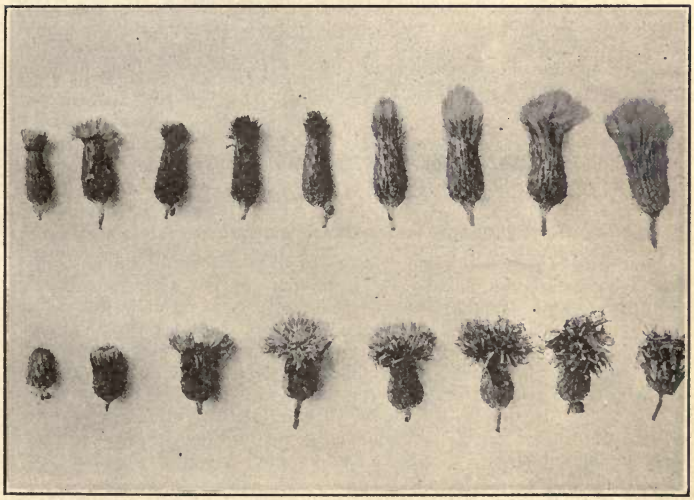


FIG. 95. Heads of Canada thistle, in the order of their stages of development; Top row, the female; bottom row, the male. (N. Z. Journ. Agric.)

ties, and at least one infestation has been reported from Los Angeles County. It is also more or less abundant in Humboldt and other northern counties.

In the south, the Canada thistle produces seed rarely or not at all. Unlike other thistles, the Canada thistle produces two types of flowers, male and female, which are nearly always borne on separate plants. The male heads are nearly round, short and stumpy, and more or less

[1]Technical Assistant, California Department of Agriculture, Sacramento, Cal.

flattened near the top. The female heads are somewhat elongated, and narrowed in at the top. For seed to be formed it is necessary for the pollen to be carried by insects from the male to the female plants. Even then seed is frequently not formed, since hot weather destroys either the pollen or the stigmatic surface, and fertilization fails to take place.

Most of the patches in southern California have apparently developed from a single seed, hence are usually of one sex only, and the development of seed is impossible.

In company with Earl L. Morris and G. W. Wardwell, I examined a large number of female heads in various localities of the Santa Ana delta section this season (1920) but was unable to find a single viable seed.

That seeds are occasionally formed in certain years is not improbable, although its spread in that section can be explained by its introduction as an impurity in imported beet seed and by the washing down of pieces of the rootstock from lands upstream during the heavy floods which occasionally occur.

In spite of the handicap of not producing seed, the Canada thistle is an exceedingly unwelcome intruder. Its rootstocks are not infrequently twenty feet long, producing plants at frequent intervals, and being exceptionally persistent in the face of control measures. In fact, the only means known to eradicate it is to prevent it from forming green leaves over a period of two years.

BEAN WEEVILS IN CALIFORNIA.[1]

By ANDREW O. LARSON,[2] Alhambra, California.

LOSSES FROM BEAN WEEVILS.

According to statements from officials of the California Bean Growers' Association, and others, who are prominent in the bean industry in California, losses caused by bean weevils[3] have been gradually increasing year by year until 1918 when an exceptionally heavy loss was sustained.

Apparently a number of factors combined to make losses greater that year than ever before. Some of these factors are: (1) The greater acreage and correspondingly greater yield; (2) early planting of much of the crop; (3) spread of weevils, through seed or otherwise, to previously uninfested areas; (4) unusually hot weather in some sections early in the summer; (5) unseasonable rains early in September; (6) shortage of labor.

The U. S. Bureau of Crop Estimates gives the acreage of 1917 as 558,000 and the California Bean Growers' Journal, Vol. 1, No. 2, page 24, estimates the yield in 1917 as 3,616,000 centals (100-pound sacks); while in 1918 it was 4,405,000 centals, exclusive of limas, which are estimated at 1,545,000 centals.

According to H. W. Nimms of the California Bean Growers' Association and J. E. Clifford of the Sacramento Public Bean Cleaner, and others, the early beans are looked upon with disfavor and are put onto

[1]Published with the approval of the Secretary, U. S. Dept. of Agriculture.
[2]Scientific Assistant, Bureau of Entomology, U. S. Dept. of Agriculture, Alhambra, California.
[3]*Bruchus obtectus* Say and *B. quadrimaculatus* Fab.

the market as soon as possible because the degree of infestation is likely to be high. "They are good beans to be rid of." A quotation from the Pacific Rural Press of April 12, 1919, while of questionable value in itself, gives the opinion quite generally held by many of the leading bean growers:

AVOID BEAN WEEVILS.

"To avoid weevils in Lady Washington beans, David Klotc of Sacramento County believes July planting works. In 1917 he planted a few in his garden late in May and got about 100 pounds, all 'buggy.' In 1918 he planted about July 7 and got no bugs, though a neighbor with three acres planted about June 1, 1918, harvested 21 sacks, 'alive with bugs.' Mr. Klotc's beans matured in fine shape from July planting, as this variety requires only about 90 days."

While some bean-growing sections such as Salinas and Lompoc are free from weevil injury, other sections, notably points in the San Fernando Valley, reported weevil injury in 1918 for the first time.

Various parts of California reported unusually hot weather in July and August, causing bean blossoms to fall and early beans to ripen prematurely.

The north and central parts of the state received an unprecedented amount of rainfall beginning about September 11 and continuing until early in October. It did a great amount of damage to prunes, raisins and beans. The rainfall, together with the shortage of labor, made it necessary for the beans to remain in the fields longer than usual before thrashing. The labor shortage was also felt in the warehouses, where many of the beans were stored before they were properly dried. Many of the warehouse men claim that beans which have been rained on "always get buggy."

Whether the foregoing or other reasons caused the greater activity of the weevils, the fact is that they caused an enormous loss estimated at from 2 to 33 per cent of the crop, according to the variety of beans. While exact figures are not available, estimates from various well-informed men from the bean centers—Sacramento, San Francisco, Stockton, Modesto, Los Angeles and San Diego—all agree that the above estimate is conservative.. David F. Lane, general manager of the Turlock Merchants' and Growers' Association, Inc., said: "My idea is that one-third of the crop of 1918 was infested with weevil. I do not think this is exaggerating. I base this percentage on the amount of offerings or samples that we take during the day. Out of eight lots we have had to turn down four, and out of twelve lots, ordered to be inspected by a certain bank, we had to turn down four. In taking a general average of all beans offered us during the week I do not think that we have been able to accept more than 66 2/3 per cent." While this undoubtedly is true in a very large bean-growing section adjacent to Turlock, Modesto and Merced, it seems too high for the entire state. J. Waterman of the Waterman Selling Agency in Los Angeles and Oxnard, said: "Ten per cent injury from bean weevils to all varieties of beans in this state is very conservative. While it is a little too high for limas, it is far too low for some other varieties, notably pinks, black-eyes and whites." Accepting Mr. Waterman's estimate of damage and

5,150,000 as the number of centals of beans produced and 8 cents per pound as the value of the beans (which in the fall of 1918 was low until the importation of Oriental beans broke the market) we have a loss of 515,000 sacks of beans, worth $8 per sack, or $4,120,000. If this estimate is even cut in half, the loss is still enormous.

IDENTITY OF WEEVILS CAUSING DAMAGE TO BEANS.

As far as the writer has been able to learn, this injury is all caused by two species, the four-spotted weevil (*Bruchus quadrimaculatus* Fab.) and the common bean weevil (*Bruchus obtectus* Say.). Before this investigation began, it was supposed that the common bean weevil was causing all the damage, as *B. quadrimaculatus* had not been reported in the state. However, the writer finds that W. B. Parker collected specimens of this species in El Centro in 1913. It is now quite widely distributed, specimens having been taken by the writer from Sacramento, Lodi, Stockton, Ripon, Los Angeles, Wilmington, Huntington Beach, Santa Ana, Puente and Corona.

NOTES ON BRUCHUS QUADRIMACULATUS.

Bruchus quadrimaculatus confines its operations to black-eyed cowpeas, as far as the writer has observed, but others, notably Dr. E. A. Back (Farmers' Bulletin 983) reports it attacking other varieties of peas and beans. This led the writer to try to rear it on Mexican reds, pinks and Lady Washingtons. After daily observations as to the variety of bean on which it prefers to oviposit, the writer concluded that its preference was in the following order: first, Mexican reds; second, pinks; third, blackeyes; and fourth, Lady Washingtons. Because of this decided preference for the Mexican reds and also because the eggs can be seen most easily on that variety, it was used for making daily records of the number of eggs deposited by each of a series of females during their lives. As a result, eggs were laid by each female on all varieties but principally on Mexican reds. All the eggs were put together in one container for each day. Towards the latter part of the series only Mexican reds were used. Between July 7 and 25, 5718 eggs were deposited; of these 2661 were on Mexican reds having no other variety among them. Of the other 3057 eggs, the majority were on Mexican reds and 358 weevils emerged from the black-eyed cowpeas. Approximately two-thirds of the eggs deposited on black-eyed cowpeas produced adult weevils, while not a weevil emerged from the other varieties of beans. The young larvæ in some instances had bored into the cotyledons of beans other than blackeyes far enough to show tiny cavities after the testa had been removed, but usually the larvæ died while trying to bore their way through the testa.

The length of time required for the life cycle varies not only with temperature and moisture but also with the offspring of single pairs where the eggs were deposited within a few seconds or minutes of each other and were kept in the same small container until emergence. From 90 eggs deposited on 77 black-eyed cowpeas June 7, 52 weevils emerged, the first one appearing July 10 and the last one on July 29; while from 57 eggs deposited the following day (June 8) on 54 cowpeas 28 weevils

emerged, the first one on July 8 and the last on July 25. Of a lot of 196 eggs deposited August 15 a variation of 16 days was noted from the time the first weevil emerged until the last one appeared. Thus the weevils required from 33 to 49 days to complete their life cycle.

During the period June 8 to December 18, four generations have developed, as follows:

(1) June 8 to July 8—30 days
(2) July 8 to August 10—33 days.
(3) August 10 to September 17—38 days.
(4) September 17 to December 18—92 days (first emergence only).

There appears to be little if any difference in the time required for the development of males and females but when confined on dry beans or cowpeas the life of the adult females is from 2 to 5 days longer than that of the males. During the summer, the females lived from 9 to 20 days, while the males lived from 7 to 19 days, with the majority living only 14 days.

Mating usually takes place a few hours after emergence, and egg laying begins the next day, but sometimes eggs were deposited before the weevils were 24 hours old while in other cases several days elapsed before oviposition began. The number of eggs laid varies daily with the same individual and with different individuals, the greatest number usually being deposited when the weevil is about 3 days old. Thirty-nine eggs in one day and 117 for one individual are the highest numbers recorded by the writer. In summer, 85 is about the average for one female. The following is a typical example: (the female emerged September 20 and died October 6).

Sept.	21	22	23	24	25	26	27	28	29	30	Oct.	1	2	3	4	5	6	
Eggs	15	17	4	13	6	15	7	0	4	0	Eggs	2	0	0	1	0	0	Total 84.

So far as the writer has observed in the field, eggs were deposited only on the pods of black-eyed cowpeas, usually only a few eggs being found on a pod; but as many as 63 have been found by the writer on one pod. Apparently the weevil prefers to oviposit on pods where the cowpeas are just beginning to harden, the writer having never observed new-laid eggs on ripe pods where green ones could be found. The eggs are laid singly and are firmly cemented to the pod in the field or the bean in storage. As the young larva bores its way through the under surface of the egg it fills the eggshell with borings, giving the shell a straw-white appearance.

NOTES ON BRUCHUS OBTECTUS.

The habits of *Bruchus obtectus* are quite different from those of *B. quadrimaculatus,* although the larval stages are very similar. In the field, *B. obtectus* gnaws a hole in the green pod, showing a dislike for only limas and teparies among the many varieties observed by the writer. However, it successfully attacks both of the above varieties. The holes are gnawed into the sides of the pods or into the sutures, preferably the dorsal suture. After a hole has been made eggs are deposited therein. Following the deposition of each egg the weevil turns around and uses its mouth-parts to force the egg further into the pod. The

writer has observed one female thus deposit 14 eggs in 5 minutes. He has counted as many as 67 eggs which had been thus inserted into one hole adjacent to the dorsal suture. While this weevil inserts its eggs in young, tender pods it prefers to find pods that are ripe, as these usually crack open at least for a very short distance along the dorsal suture. These tiny openings in the suture are found and the eggs are deposited in them in great numbers. The early beans are far enough advanced to receive eggs before the later pods are sufficiently developed. When the early pods ripen and begin to crack open the weevil apparently confines its attack to them, leaving the later beans free.

In stored beans, *B. obtectus* eggs are deposited loose among the beans so that a little agitation causes them to fall to the bottom of the container. A casual observer, therefore, does not see the eggs at all.

It appears that *B. obtectus* shows more uniformity of oviposition and emergence than does *B. quadrimaculatus*. Equal numbers of eggs of each species when deposited the same day and kept under like conditions show that *B. quadrimaculatus* will begin to emerge from two to five days before any of the others appear but it also continues to emerge several days after *B. obtectus* is through emerging. *B. obtectus* seldom oviposits until it is two or three days old; then it deposits a fairly uniform number of eggs daily; the daily and total number of eggs being as a rule smaller than is the case with *B. quadrimaculatus*. The period during which the former oviposits is the greater.

Typical Examples of Egg-Laying of B. obtectus. Both Emerged June 30.

July	1:	2:	3:	4:	5:	6:	7:	8:	9:	10:	11:	12:	13:	14:	15:	16:	17	: Total	: Died
Eggs	0:	15:	15:	5:	5:	7:	5:	7:	4:	7:	2:	5:	0:	0:	0:	0:	0	: 77	: 7/22
Eggs	0:	10:	12:	0:	0:	11:	2:	2:	1:	2:	5:	5:	0:	2:	10:	3:	7	: 72	: 7/24

The highest number the writer has observed from one female in one day is 26 and 85 is the highest total recorded by him for the life of an individual. Probably greater numbers are deposited in the field, as the writer has found 67 eggs inside a pod adjacent to one puncture. He has recorded the emergence of 35 weevils from three pink beans, the contents of one pod having only one puncture when collected. He also recorded the emergence of 37 weevils from four Lady Washington beans, the contents of one pod. From the very few days required for the emerging period, it would appear that the eggs in each pod had been deposited the same day if not by the same female.

MECHANICAL DEVICES IN CONTROL OF BEAN WEEVILS.

Bean dealers frequently suggest that a mechanical agitator could be made which would be capable of eliminating the weevil in stored beans. This led the writer to try shaking vigorously each day a vial containing pink beans with a few *B. obtectus* and their eggs. On June 26, ten weevils were put on 58 beans in a glass container; they were shaken vigorously each day. No weevils were removed until the last one was dead and the eggs were left in the vial. August 13 emergence began and 116 emerged between that date and August 21. On examining the beans after August 21 they were found to contain 36 dead larvæ, 4 pupæ and 14 adults, all dead. Of these, one adult and 31 larvæ had evidently starved in one bean. There were 28 beans containing no

weevils. A check of 48 beans and ten weevils, receiving the same treatment except for shaking, showed emergence of 266 between August 7 and 19. Later examination showed 4 larvæ, 5 pupæ, and 14 adults dead within the beans. Only 12 beans were free.

A revolving cylinder with finely perforated walls would probably be effective on a small scale. It could be turned a few minutes every fourth day in warm weather and would throw out the eggs which had been deposited since the last agitation. This, however, would be of no use in controlling *B. quadrimaculatus* because the eggs are cemented too firmly to the bean. The expense of operating would prohibit its use commercially as a control for *B. obtectus.*

FUMIGATION IN CONTROL OF BEAN WEEVILS.

The results of numerous fumigation tests with carbon disulphide show it to be an effective means of control in the warehouse. The following data shows the efficiency of fumigation when done properly. The sample, 200 beans, was taken from a lot of badly-infested cranberry beans which had been fumigated 48 hours with six pounds of carbon disulphide to 900 cubic feet.

Results of Fumigating Infested Beans With Carbon Disulphide.

Number of beans	Number weevils in each	Per cent of sample	Adults	Pupæ	Larvæ	Per cent dead
41	0	20.5				
39	1	19.5				
40	2	20.0				
24	3	12.0				
20	4	10.0				
14	5	7.0				
9	6	4.5				
7	7	3.5				
1	8	.5				
2	9	1.0				
2	10	1.0				
1	12	.5				
200		100.0	1	108	393	100

Later trials show that the eggs also are killed by this treatment, the writer finds.

NATURAL ENEMIES.

Undetermined chalcids have been found working on *B. quadrimaculatus,* and a predaceous mite, determined by Dr. Ewing as probably *Pediculoides ventricosus* Newport, has been found by the writer attacking both species. While the mite is a very effective check in the laboratory, it causes so much human discomfort that its use is not to be recommended.

QUARANTINE SERVICE.

REPORT FOR THE MONTH OF JUNE, 1920.

By FREDERICK MASKEW.

SAN FRANCISCO STATION.

Steamship and baggage inspection:

Ships inspected	88
Passengers arriving from fruit-fly ports	5,901

Horticultural imports:

	Parcels
Passed as free from pests	76,673
Fumigated	1,593
Refused admittance	38
Contraband destroyed	130
Total parcels horticultural imports for the month	78,434

PESTS INTERCEPTED.

From Central America:

Pseudococcus sp. and *Aspidiotus cyanophylli* on bananas.

From China:

Formicid (undetermined) in water chestnuts.
Lepidopterous larva in dry herbs.
Larva of borers (undetermined) in twigs.

From Hawaii:

Diaspis bromeliae and *Pseudococcus bromeliae* on pineapples.
Larva of Trypetid (undetermined) in tomatoes.
Coccus elongatus and *Aphis* sp. on betel leaves.
Hemichionaspis minor on red peppers.
Saissetia nigra and *Pseudaonidia duplex* on hibiscus cuttings.

From Japan:

Fungus (undetermined) on Japanese pears.
Lepidopterous larva (undetermined) in dried chestnuts and dried fruit.

From Mexico:

Calandra sp. and *Silvanus surinamensis* in squash seed.
Lepidosaphes gloverii and *Chrysomphalus aurantii* on limes.

From New Zealand:

Larva of Diptera (undetermined) in decayed potatoes.

From Oregon:

Actinomyces scabies, Rhizoctonia and Fusarium on potatoes.
Epochra canadensis in gooseberries.

From Pennsylvania:

Pseudococcus sp. on Gardenia.

From San Salvador:

Lepidosaphes gloverii and *Lepidosaphes beckii* on limes.

From Washington:

Actinomyces scabies, Rhizoctonia and Fusarium on potatoes.

LOS ANGELES STATION.

Steamship and baggage inspection:

Ships inspected	56
Fish boats inspected	7
Passengers arriving from fruit-fly ports	11

Horticultural imports:

	Parcels
Passed as free from pests	65,891
Fumigated	12
Refused admittance	24
Contraband destroyed	21
Total parcels horticultural imports for the month	65,948

PESTS INTERCEPTED.

From Alabama:

Melanose and *Lepidosaphes beckii* on grapefruit.

From Central America:

Pseudococcus sp., *Aspidiotus cydoniae* and *Aspidiotus cyanophylli* on bananas.

From Cuba:

Diaspis bromeliae on pineapples.

From Illinois:

Lecanium corni on black currant bushes.

From Mexico:

Unidentified weevils in tamarinds.
Anastrepha ludens in mangoes.
Chloridea obsoleta in tomatoes.

From New York:

Green aphis and *Tetranychus* sp. on chrysanthemum plants.
Melanose, unidentified fungus and *Lepidosaphes beckii* on Cuban grapefruit.
Melanose and *Lepidosaphes beckii* on Florida grapefruit.

From Ohio:

Green aphis on chrysanthemum plants.

From Oregon:

Rhizoctonia on potatoes.

From Philippine Islands:

Larva on weevil in sweet potatoes.

From Texas:

Tetranychus mytilaspidis, Aleyrodes sp. and *Ceroplastes floridensis* on Cape jessamine buds.

SAN DIEGO STATION.

Steamship and baggage inspection:

Ships inspected	22
Fish boats inspected	36
Passengers arriving from fruit-fly ports	40

Horticultural imports:

	Parcels
Passed as free from pests	6,436
Fumigated	0
Refused admittance	7
Contraband destroyed	8
Total parcels horticultural imports for the month	6,451

PESTS INTERCEPTED.

From Central America:

Aspidiotus cyanophylli, Aspidiotus sp. and *Pseudococcus* sp. on bananas.

From Mexico:

Diatraea saccharalis in sugar-cane.

From North Dakota:

Rhizoctonia on potatoes.

From Utah:

Rhizoctonia on potatoes.

EUREKA STATION.

Steamship and baggage inspection:

Ships inspected	6
Passengers arriving from fruit-fly ports	0

Horticultural imports:

	Parcels
Passed as free from pests	15

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